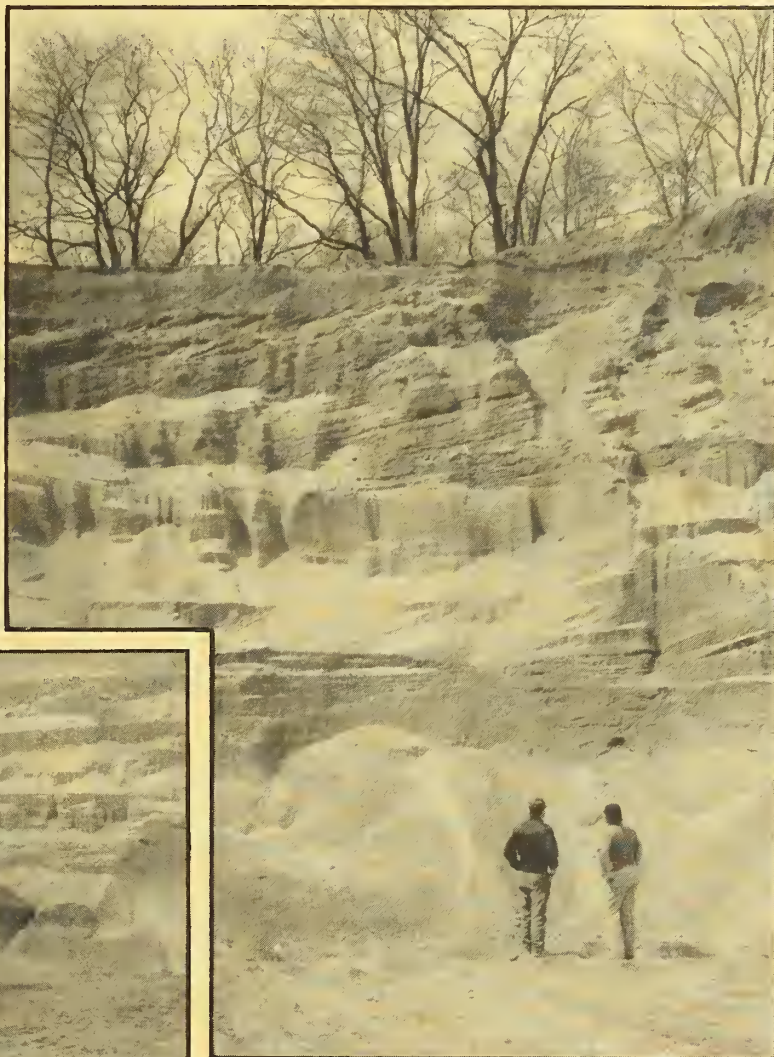



# Guide to the Geology of the Pekin Area, Tazewell and Peoria Counties, Illinois

W.T. Frankie  
R.J. Jacobson  
D.L. Reinertsen  
R.S. Nelson  
D.H. Malone



Field Trip Guidebook 1995B May 20, 1995

Department of Energy and Natural Resources  
ILLINOIS STATE GEOLOGICAL SURVEY



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ILLINOIS STATE GEOLOGICAL SURVEY

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**Cover photos by W.T. Frankie** (*upper right*) Exposure of glacial outwash sediments, showing large scale cross-beds at the Hurley Sand and Gravel Pit, southwest of Pekin. (*lower left*) Mining operation using a front-end loader to remove sand and gravel from the Hurley Pit.

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**Geological Science Field Trips** The Educational Extension Unit of the Illinois State Geological Survey (ISGS) conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

A list of guidebooks of earlier field trips for planning class tours and private outings may be obtained by contacting the Educational Extension Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820. Telephone: (217) 244-2427 or 333-4747.

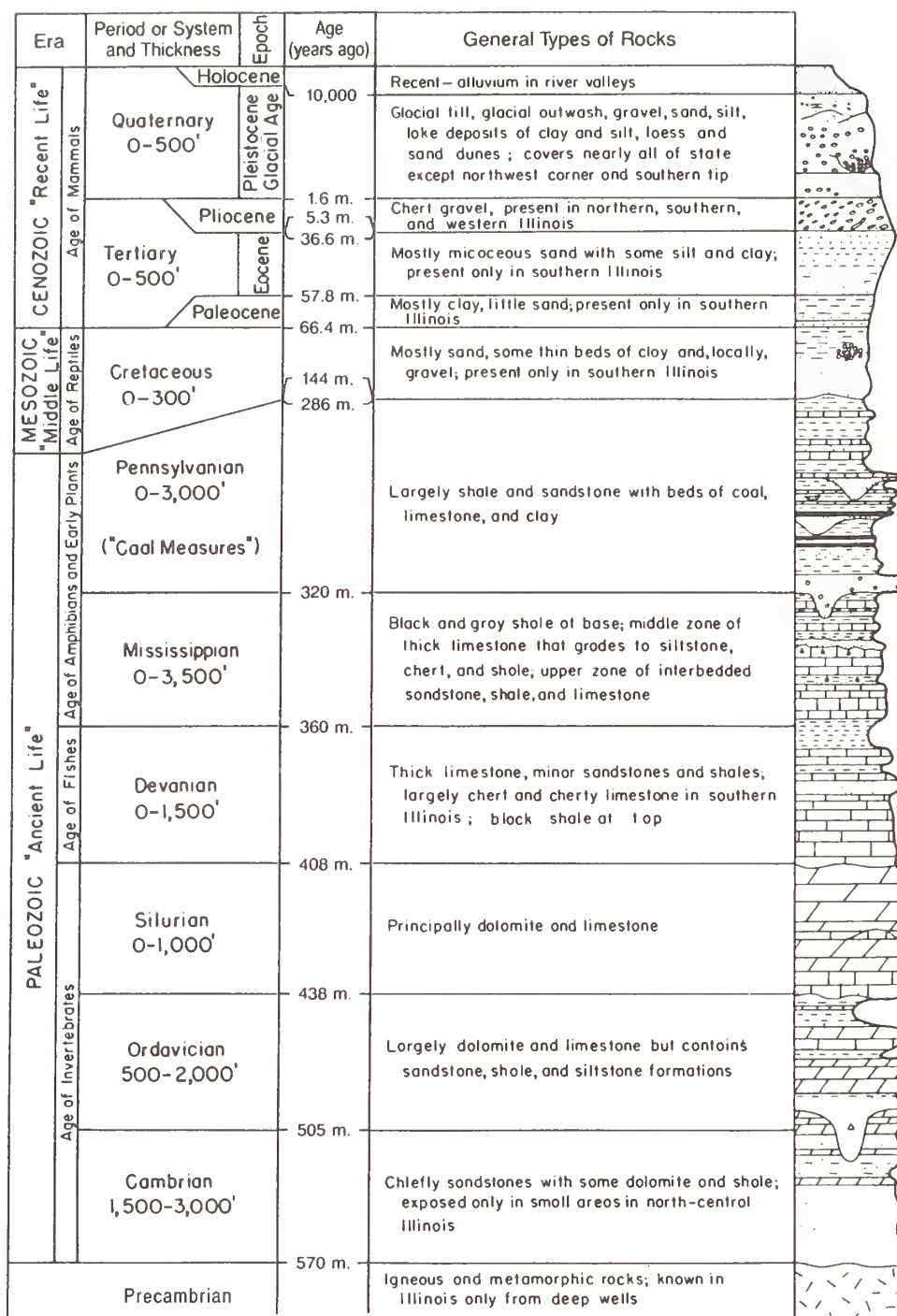


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Generalized geologic column showing succession of rocks in Illinois.

## PEKIN AREA

The Pekin geological science field trip will acquaint you with the *geology*<sup>\*</sup>, landscape, and mineral resources for part of Tazewell and Peoria counties, Illinois.

The Pekin area is located in the north-central portion of Illinois along the Illinois River. It is 160 miles southwest of Chicago, nearly 170 miles north-northeast of St. Louis, and about 300 miles north of Cairo.

### Geologic Framework

**Precambrian Era** Through several billion years of geologic time, the area surrounding Tazewell and Peoria counties has undergone many changes (see the rock succession column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian *basement complex*. We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 35 drill holes have reached deep enough for geologists to collect samples from Precambrian rocks. From these samples, however, we know that these ancient rocks consist mostly of granitic and rhyolitic *igneous*, and possibly *metamorphic*, crystalline rocks formed about 1.5 to 1.0 billion years ago. These rocks, which were deeply weathered and eroded when they were exposed at Earth's surface until about 0.6 billion years ago, formed a landscape that was probably quite similar to that of the present-day Missouri Ozarks. We have no rock record in Illinois for the long interval of *weathering* and erosion that lasted from the time the Precambrian rocks were formed until the Cambrian sediments accumulated, but that interval is almost as long as the time from the beginning of the Cambrian to the present.

Geologists seldom see Precambrian rocks in Illinois except as cuttings and cores from drill holes. To determine some of the characteristics of the basement complex, they use various techniques, such as surface mapping of the measurements of Earth's gravitational and magnetic fields, and seismic exploration. The evidence indicates that in southernmost Illinois, near what is now the Kentucky-Illinois Fluorspar Mining District, *rift* valleys like those in east Africa, formed as movement of crustal plates (plate *tectonics*) began to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

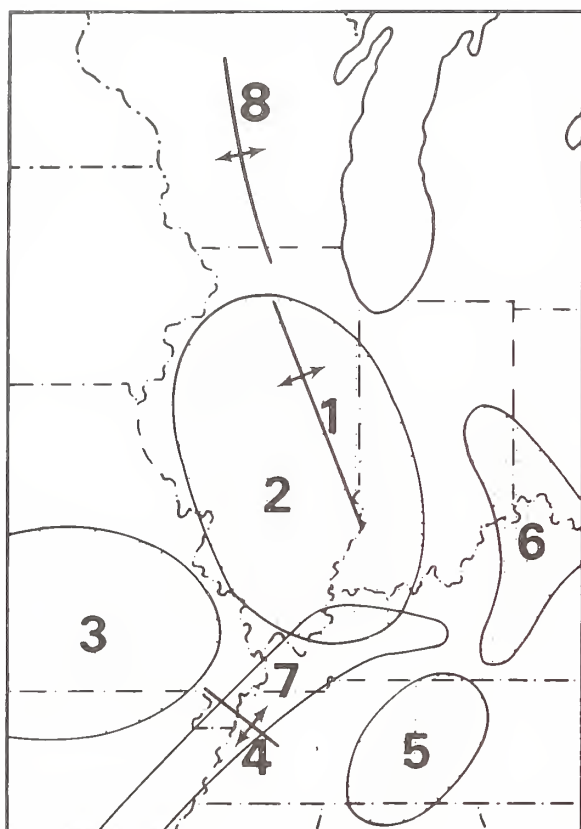
**Paleozoic Era** Near the beginning of the Paleozoic Era about 570 million years ago, the rifting stopped and the hilly Precambrian landscape began to sink slowly on a broad, regional scale, allowing the invasion of a shallow sea from the south and southwest. During the several hundred million years of the Paleozoic Era, the area that is now southern Illinois continued to accumulate sediments deposited in the shallow seas that repeatedly covered it. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At times during this era the seas withdrew and deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois.

In the field trip area, *bedrock* strata range from more than 520 million years (the Cambrian *Period*) to less than 290 million years old (the Pennsylvanian Period). Figure 2 shows the succession of rock units a drill bit would penetrate in this area if all the *formations* listed were present.

Pennsylvanian-age bedrock strata consisting of shale, siltstone, sandstone, limestone, coal, and underclay were deposited as sediments in shallow seas and swamps between about 320 and 288 million years ago. They are found immediately beneath a cover of glacial deposits in this area. Some of these rocks are exposed in scattered roadcuts and stream cuts.

---

<sup>\*</sup>Words in italics are defined in the glossary at the back of the guidebook. Also please note: although all present localities have only recently appeared within the geologic time frame, we use the present names of places and geologic features because they provide clear reference points for describing the ancient landscape.



**Figure 1** Location of some of the major structures in the Illinois region. (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben-Reelfoot Rift, and (8) Wisconsin Arch.

Pennsylvanian strata increase in total thickness from less than 200 feet in western Tazewell County to more than 600 feet in the east. (See *Depositional History of the Pennsylvanian Rocks* in the supplemental reading at the back of this guidebook for a more complete description of these rocks.)

In Tazewell County, Paleozoic sedimentary strata range from about 4,400 feet thick in western Tazewell County to about 5,350 feet in the east.

### **Structural and Depositional History**

As noted previously, midcontinent rift valleys (the Rough Creek Graben and the Reelfoot Rift, figs. 1 and 3) formed during Precambrian tectonic activity. These valleys later filled with sand and gravel that was shed from the adjacent uplands and with limestone that formed in the shallow sea covering the area.

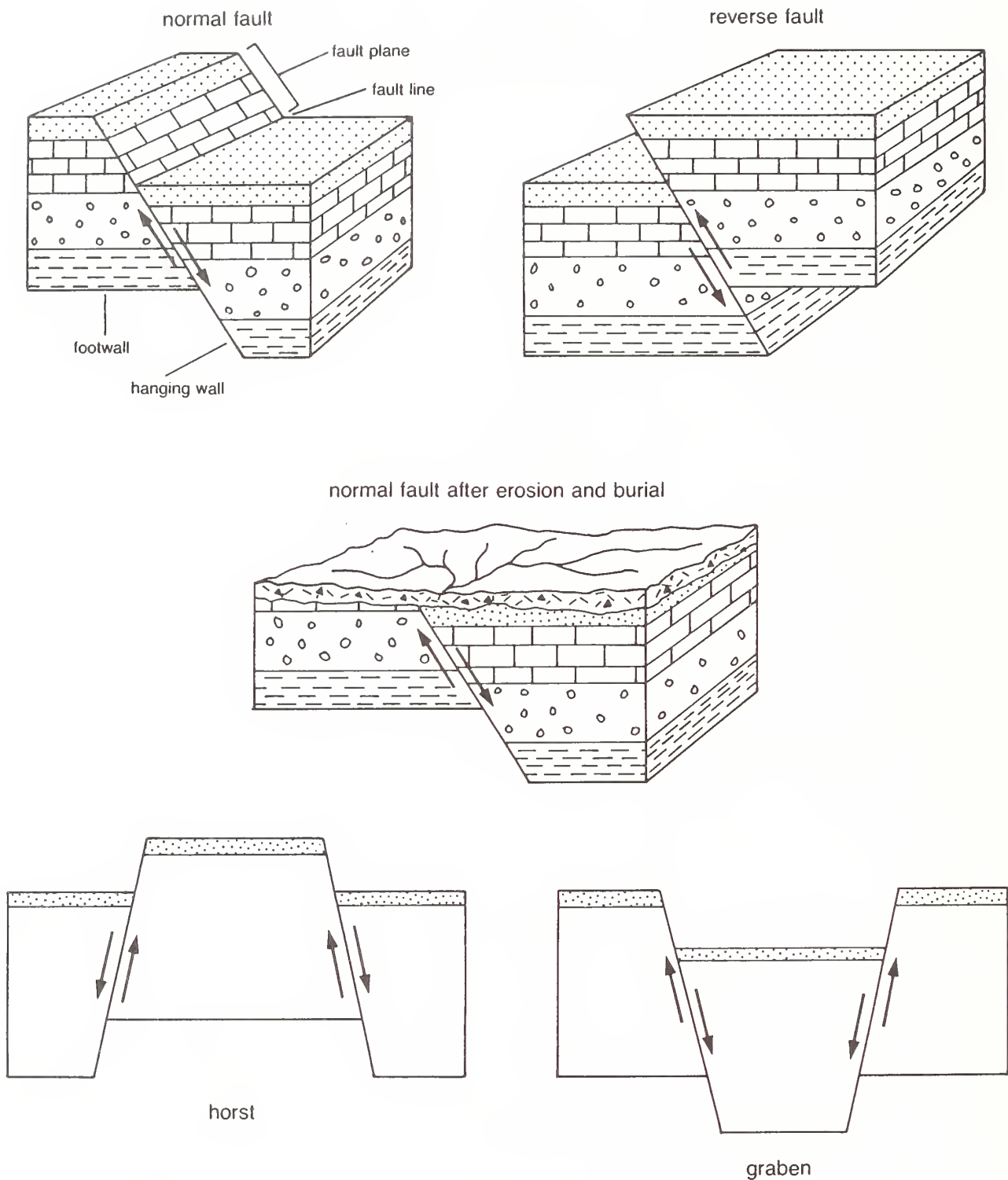
During the Paleozoic Era, sediments accumulated in the seas that covered Illinois and adjacent states. The shallow seas connected with the open ocean to the south during much of the Paleozoic, and the area of southern Illinois was an embayment. The southern part of Illinois and adjacent parts of Indiana and Kentucky sank more rapidly than the areas to the north, allowing a greater thickness of sediment to accumulate. Earth's thin crust was periodically flexed and warped as stresses built up. These worldwide movements caused changes in sea level that resulted in repeated invasions and withdrawals of the seas across the region. Former sea floors were thus periodically exposed to erosion, which erased some sediments from the rock record.

Many of the sedimentary units, called formations, have conformable contacts—that is, no significant interruption in deposition occurred between formations (see frontispiece, Generalized geologic column, and fig. 4). In some instances, even though the composition and appearance of the rocks

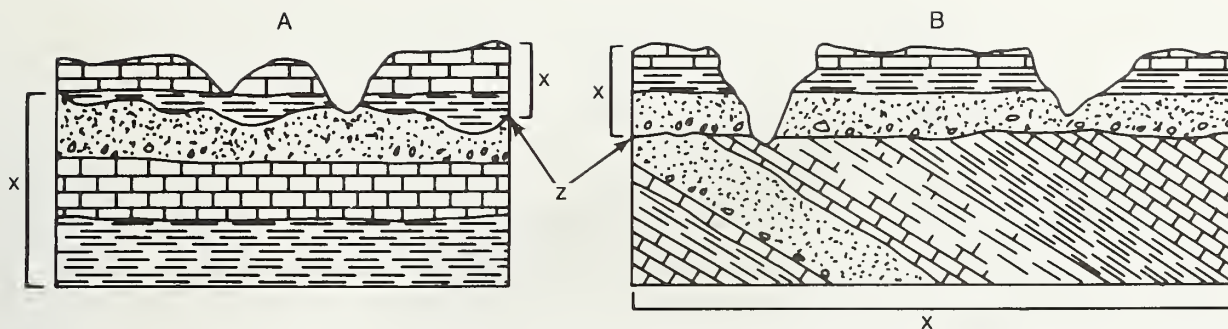


SYSTEM	SERIES	GROUP	FORMATION
QUATERNARY	PLEISTOCENE		
PENNSYLVANIAN		Mc LEANSBORO	Shelburn
			Carbondale
		RACCOON CREEK	Tradewater
MISSISSIPPIAN	VALMEYERAN		Keokuk-Burlington
	KINDERHOOKIAN	NEW ALBANY	Hannibal
DEVONIAN	UPPER		Grassy Creek
			Sylamore
	MIDDLE		Cedar Valley
SILURIAN	NIAGARAN		Joliet
	ALEXANDRIAN		Kankakee
		Edgewood	
ORDOVICIAN	CINCINNATIAN	MAQUOKETA	Brainard
			Ft. Atkinson
			Scales
	CHAMPLAINIAN	GALENA	
		PLATTEVILLE	
		ANCELL	Glenwood-St. Peter
	CANADIAN	PRAIRIE DU CHIEN	Shakopee
			New Richmond
Oneota			
Gunter			
CAMBRIAN	CROIXAN		Eminence
			Potosi
			Franconia
			Iron-ton
			Galesville
			Eau Claire
			Mt. Simon

**Figure 2** Generalized stratigraphic column of the Pekin Area.



**Figure 3** Diagrammatic illustrations of fault types that may be present in the field trip area (arrows indicate relative directions of movement on each side of the fault).



**Figure 4** Schematic drawings of (A) a disconformity and (B) an angular unconformity (x represents the conformable rock sequence and z is the plane of unconformity).

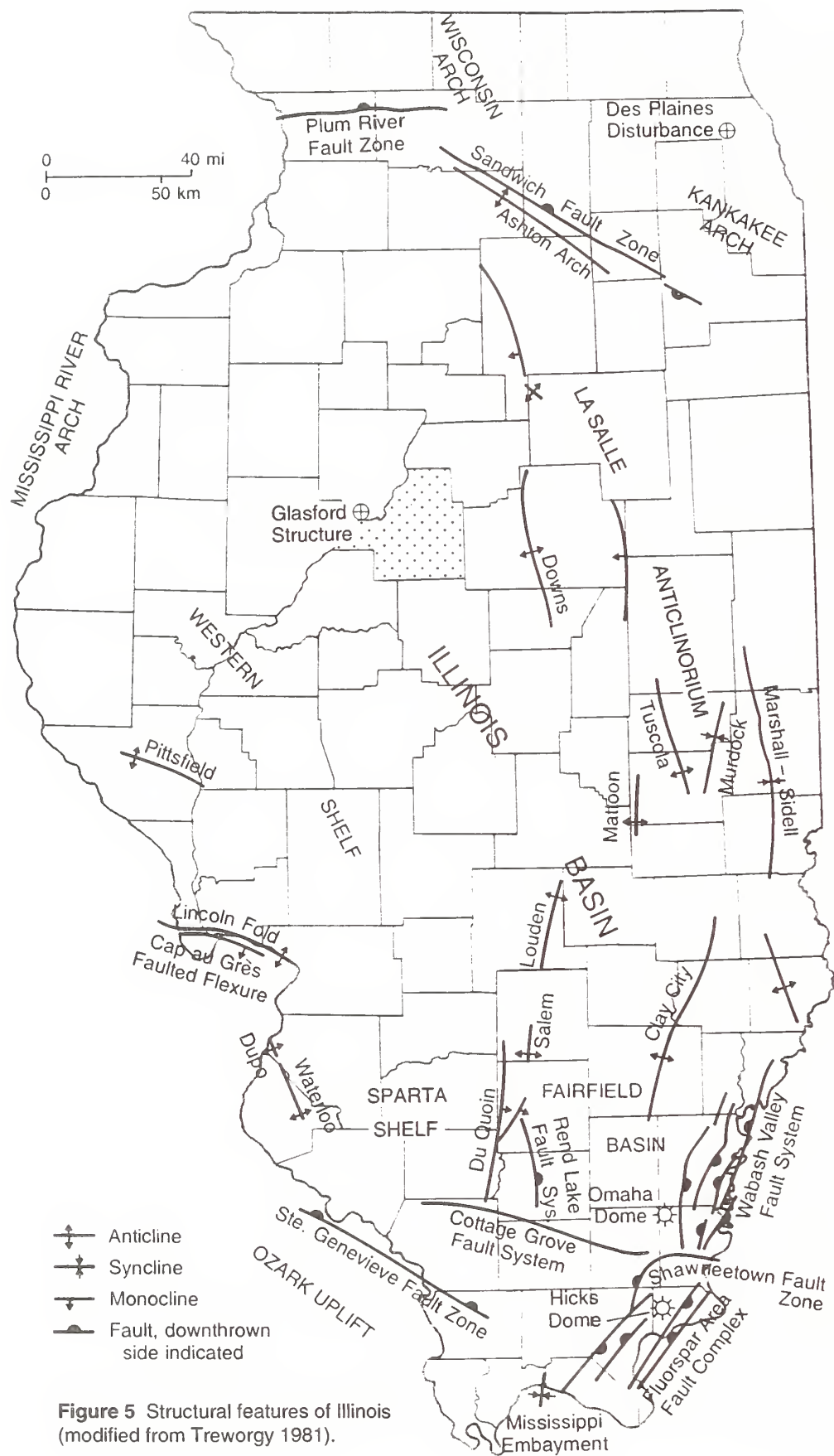
change significantly at the contact between two formations, the *fossils* in the rocks and the relationships between the rocks at the contact indicate that deposition was virtually continuous. In some places, however, the lower formation was at least partially eroded before deposition resumed. Fossils and other evidence in the two formations indicate that there is a significant age difference between the lower unit and the overlying unit. This type of contact is called an *unconformity* (fig. 4). If the *beds* above and below an unconformity are parallel, the unconformity is called a *disconformity*; if the lower beds have been tilted and eroded before the overlying beds were deposited, the contact is called an angular unconformity.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinorium (figs. 1 and 5). This is a complex structure having smaller structures such as domes, *anticlines*, and *synclines* superimposed on the broad upwarp of the anticlinorium. Further gradual arching continued through the Pennsylvanian. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (either because they were not deposited or because they were eroded), we cannot know just when movement along the belt ceased— perhaps it was by the end of the Pennsylvanian or later during the Permian Period, near the close of the Paleozoic Era.

During the Mesozoic Era, which followed the Paleozoic Era, the rise of the Pascola Arch (fig. 1) in southeastern Missouri and western Tennessee formed the Illinois *Basin*, closing off the embayment and separating it from the open sea to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southwestern Indiana, and western Kentucky (figs. 1 and 5). Development of the Pascola Arch, in conjunction with the earlier sinking of deeper parts of the area to the north, gave the basin its present asymmetrical, spoon-shaped configuration (fig. 6). The geologic map (fig. 7) shows the distribution of the rock *systems* of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

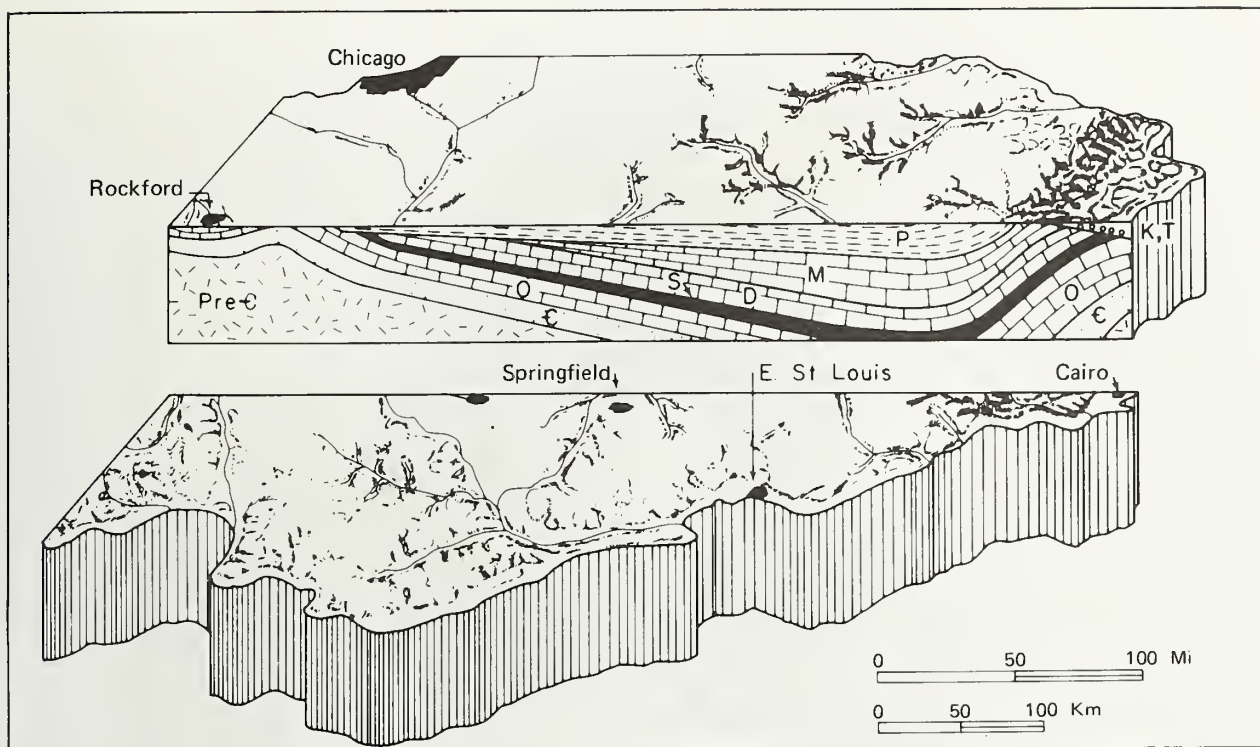
The Pekin field trip area is in the north-central flank of the Illinois Basin in an area where very few large structural features have been identified (fig. 5). The closest large scale structural feature is the Glasford Structure located in the southern portion of Peoria County (Buschbach and Ryan, 1963). Several small scale anticlines and synclines with a general east-west orientation have been identified in Peoria County north of Glasford (Nelson, 1995). Because tilting of the bedrock layers took place several times during the Paleozoic Era, the dips of successive strata vary.

Other evidence indicates that younger rocks of the latest Pennsylvanian and perhaps the Permian (the youngest rock systems of the Paleozoic) may have at one time covered the Tazewell County area. It is possible that Mesozoic and Cenozoic (even younger) rocks could also have been present here. Indirect evidence, based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks (Damberger 1971), indicates that perhaps as much as 1 1/2 miles of latest Pennsylvanian and younger rocks once covered southern Illinois. However, during the more than 240 million years since the Paleozoic Era (and before the onset of



**Figure 5** Structural features of Illinois (modified from Treworgy 1981).





**Figure 6** Stylized north-south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

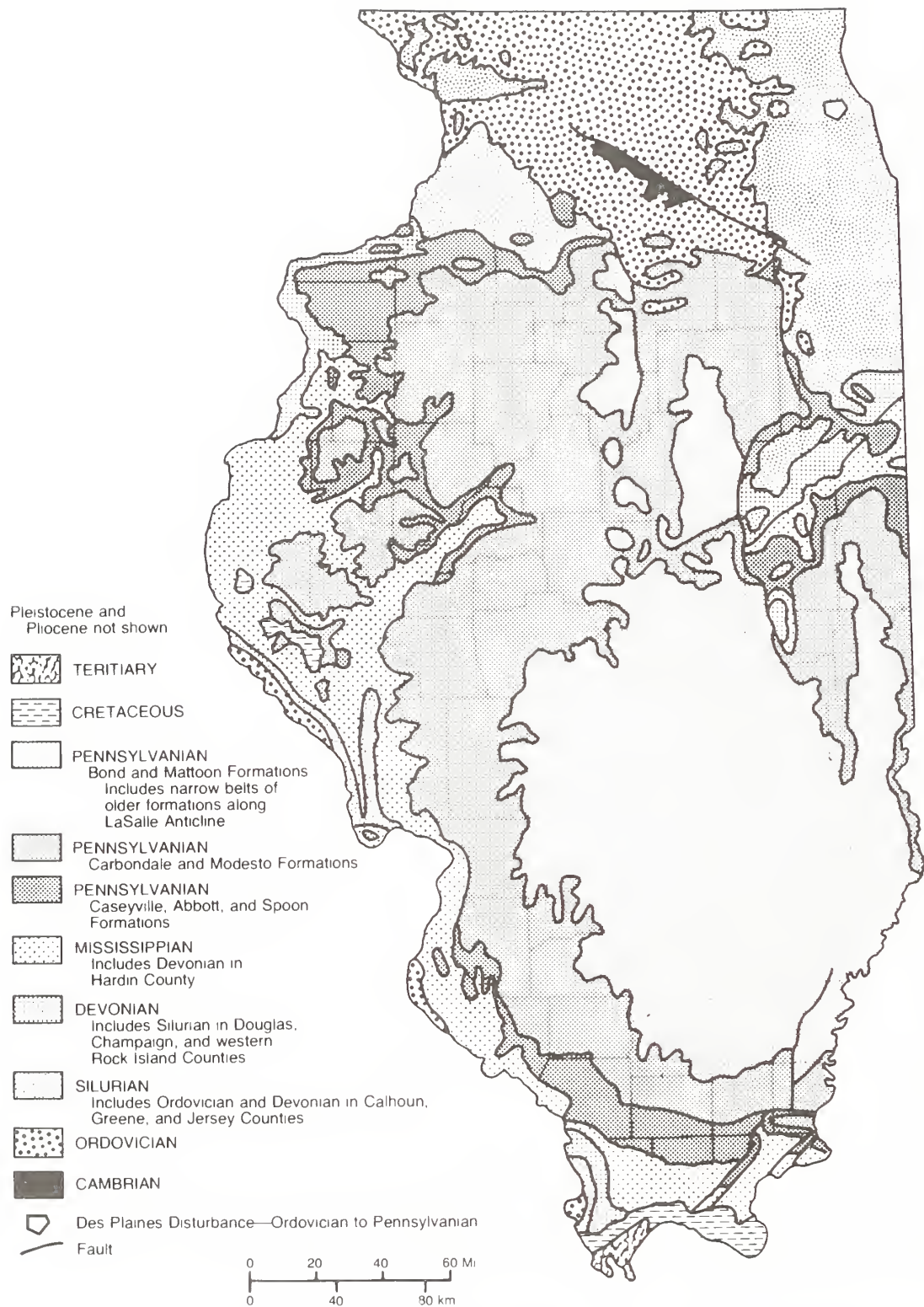
*glaciation* 1 to 2 million years ago), several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois were erased.

During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations. Later, the topographic *relief* was reduced by repeated advances and melting back of continental *glaciers* that scoured and scraped the pre-glacial erosion surface. The erosion affected all the formations exposed at the bedrock surface in Illinois. The final melting of the glaciers left behind the non-lithified deposits in which our Modern Soil has developed.

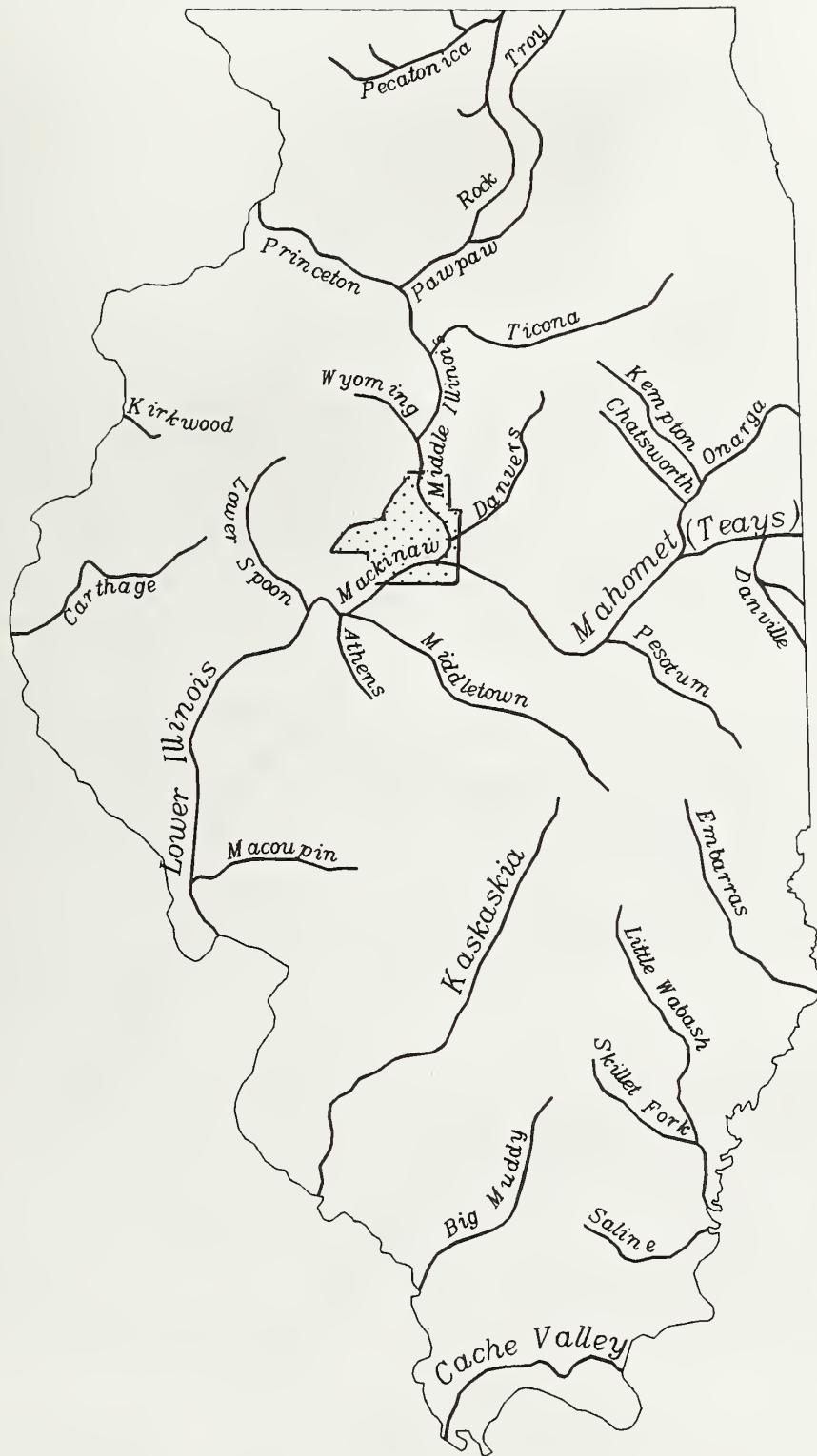
**Glacial history** A brief general history of glaciation in North America and a description of the deposits commonly left by glaciers may be found in *Pleistocene Glaciations in Illinois* at the back of the guidebook.

Erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface (fig. 8). In the Pekin area, the ancient buried bedrock drainage network includes the Mahomet/Teays Valley, Mackinaw Valley, Wyoming Valley, Danvers Valley, and the ancestral Mississippi River Valley (fig 9). Because of the irregular bedrock surface and erosion, glacial *drift* is unevenly distributed across Tazewell County.

During the Pleistocene *Epoch*, beginning about 1.6 million years ago, massive sheets of ice (called continental glaciers), thousands of feet thick, flowed slowly southward from Canada. The last of these glaciers melted from northeastern Illinois about 13,500 years before the present (B.P.). During the Illinoian glacial stage, which began around 300,000 years B.P., North American



**Figure 7** Bedrock geology beneath surficial deposits in Illinois.



**Figure 8** Bedrock valleys of Illinois, with Tazewell County highlighted (modified from Bristol and Buschbach 1973).



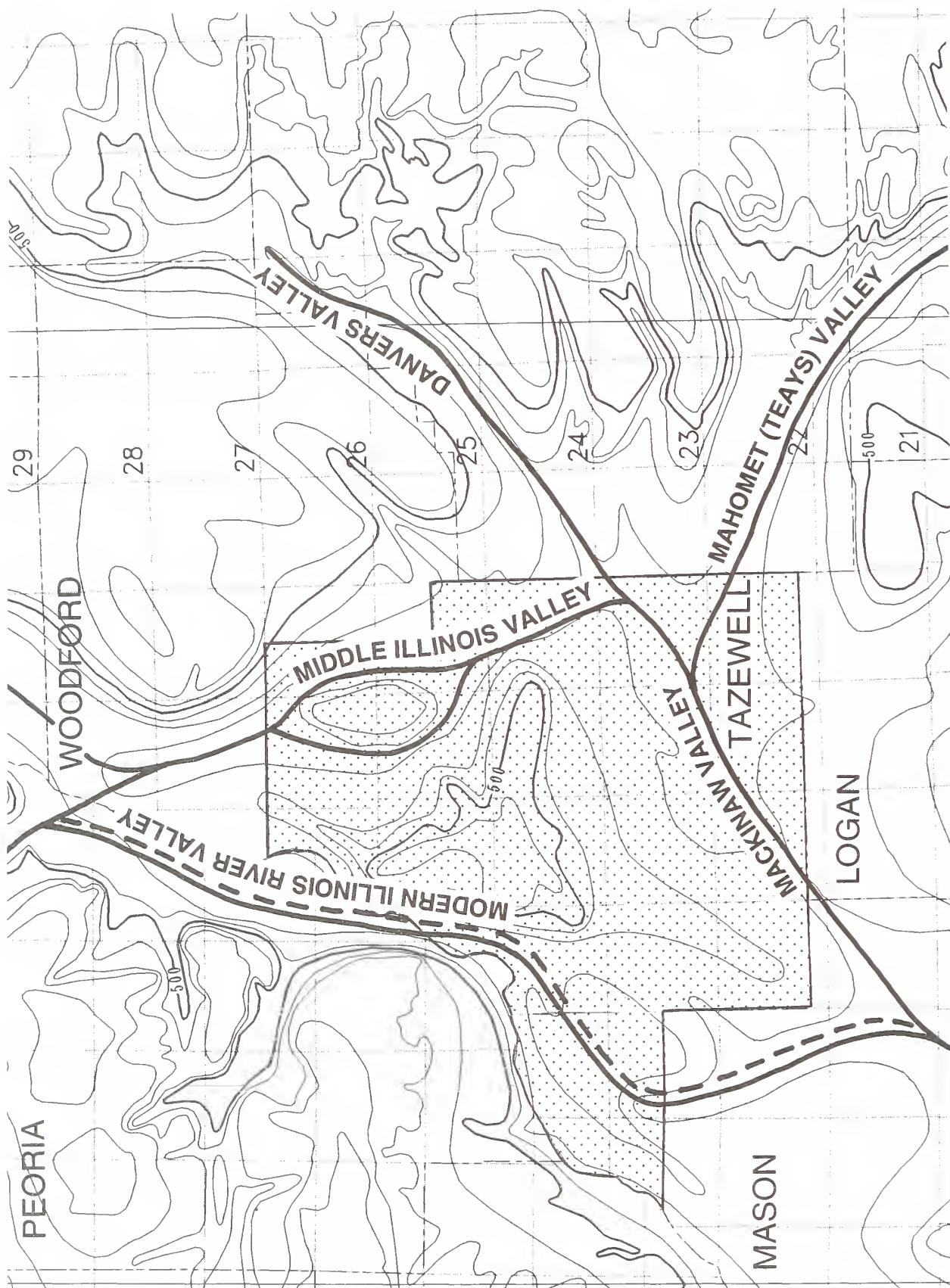


Figure 9 Detail of buried bedrock surface and valleys of Tazewell County and surrounding areas (modified from Herzog et al. 1994).



continental glaciers reached their southernmost position slightly more than 200 miles south of here (fig. 10), in the northern part of Johnson County.

Until recently, glaciologists assumed that these glaciers may have been a mile or more thick. However, the maximum thickness of the ice may have been only about 2,000 feet in the Lake Michigan Basin and about 700 feet across most of the Illinois land surface (Clark et al. 1988). That conclusion was made using several lines of research evidence: (1) the degree of consolidation and compaction of rock and soil materials that were overridden by the ice, (2) comparisons between the inferred geometry and configuration of the ancient ice masses and those of present-day glaciers and ice caps, (3) comparisons between the mechanics of ice-flow in modern-day glaciers and ice caps and those inferred from detailed studies of the ancient glacial deposits, and (4) the amount of rebound of the Lake Michigan Basin as the heavy mass of glacial ice (that had depressed the land beneath it) melted.

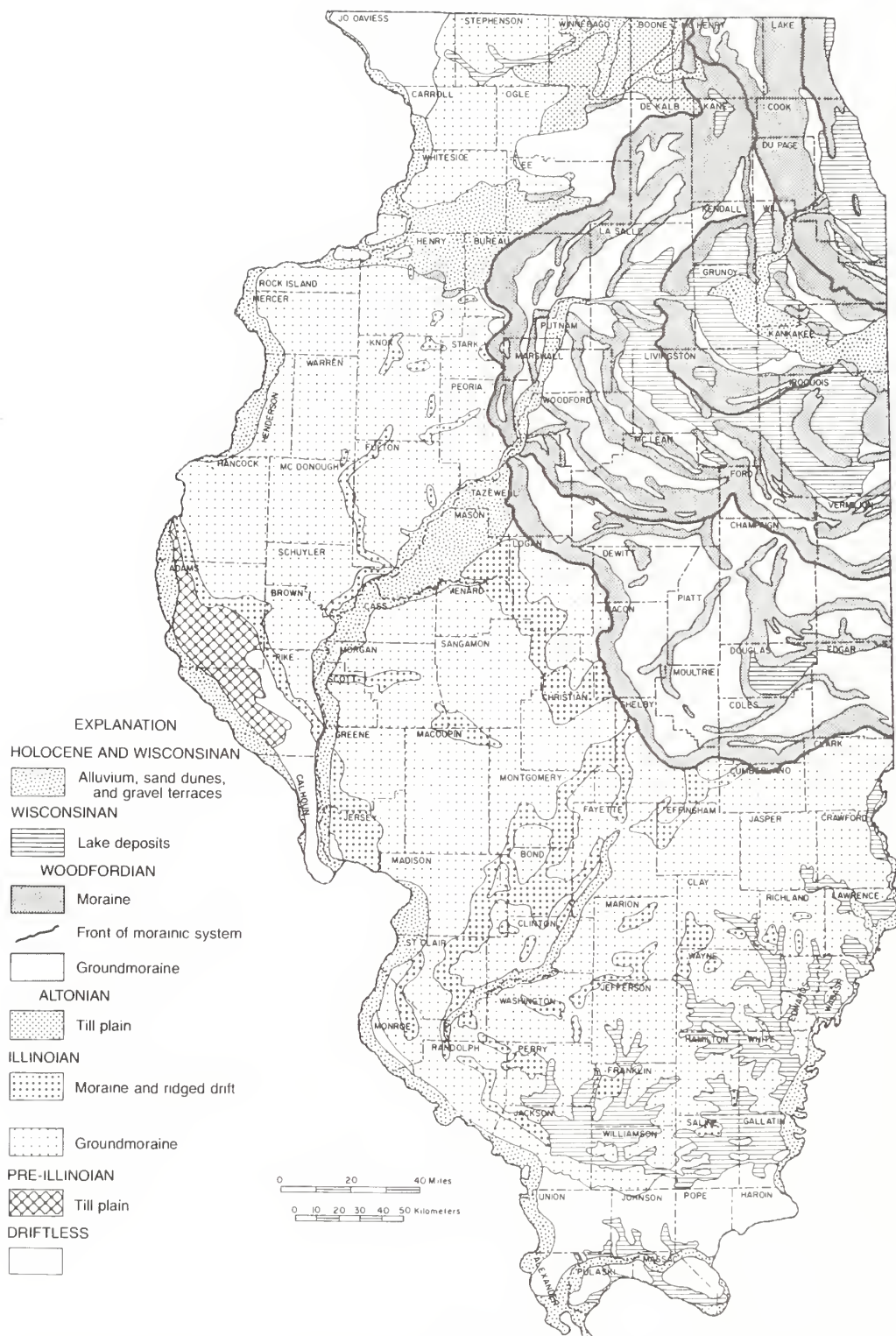
The *topography* of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits except along the major streams. In many areas, the glacial drift is thick enough to completely mask the underlying bedrock surface. Studies of mine shafts, water-well logs, and other drill-hole information in addition to scattered bedrock exposures in some stream valleys and roadcuts show that the present land surface of this region does not reflect the underlying bedrock surface. The preglacial bedrock surface has been significantly modified by glacial processes. Pekin lies near the western edge of the late Wisconsinan Shelbyville *Moraine*, the earliest moraine of the Woodfordian *Substage* that was formed about 22,000 B.P. (See *Pleistocene Glaciations in Illinois* at the back of the guidebook).

Although Illinoian glaciers probably built morainic ridges similar to those of the later Wisconsinan glaciers, Illinoian moraines apparently were not so numerous and have been exposed to weathering and erosion for thousands of years longer than their younger Wisconsinan counterparts. For these same reasons, Illinoian glacial features generally are not as conspicuous as the younger Wisconsinan features.

Up to 15 feet of wind-blown silt, called *Loess* (pronounced "luss"), mantles the glacial drift in Tazewell County. This fine-grained dust reaches thicknesses close to 100 feet near the Mississippi River. Soils in this area have developed in the loess and the underlying weathered silty, clayey Wisconsinan *till*.

***Pekin field trip area*** Some time after deposition of the Pennsylvanian age strata, the entire central area of the United States was slowly lifted above sea level, and a drainage network of streams began to form. The Teays system was a major river system that drained the western flank of the Appalachian Mountains in West Virginia and flowed westward across Ohio, Indiana, and into central Illinois. The bedrock valley associated with the Teays system in Illinois is referred to as the Mahomet Valley. The Mahomet Valley, in central Illinois, was joined by the Ancestral Mississippi River. The Ancestral Mississippi River headed in Minnesota and followed the course of the modern Mississippi from its headwaters, to near Savanna, Illinois, then it flowed eastward to near Hennepin and then southward to join the Teays/Mahomet in Illinois southeast of Pekin in southeastern Tazewell County (fig. 8). The combined rivers flowed southwestward along what is now the lower Illinois River Valley.

During the Pleistocene, the mid-continent region experienced several episodes of glaciations. A variety of sediments nearly filled the Mahomet Valley. It is of interest to note that most of the sediments filling the valley in the field trip area are sands and gravels. These sands and gravels are the major aquifers for the area.



**Figure 10** Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).



As the most recent glacier advanced into the area from the north and east, meltwater streams carried tremendous amounts of sand and gravel into the area where the ancestral Mahomet Valley and ancestral Mississippi Valley merged. This outwash was deposited as a large alluvial fan that spread westward from the position of the early Shelbyville and later LeRoy moraines.

The last glacier advanced to Peoria and blocked the Ancestral Mississippi River Valley at its junction with the Mahomet Valley. This produced a large lake that filled part of the Ancestral Mississippi River Valley until the lake overflowed and cut a new valley around the edge of the glacier. This new valley is the Modern Illinois River Valley at Peoria.

The overflow event released a spectacular flow of "energy" from the lake. As the torrent from the overflow cut down through the Pennsylvanian strata, coal and other bedrock materials were incorporated into the coarse sediments that choked the valley just below the point of release. Some of the lake sediments (laminated clayey silts) that had accumulated in the blocked river valley were ripped from the lake floor and tumbled with sand and gravel to produce armored mud balls. These armored mud balls were deposited in the coarse sediment. There may have been several episodes of massive flooding as moraine dams between LaSalle and Lake Michigan were breached. These large floods, collectively called the Kankakee Torrent, reworked the sediments and formed large sand and gravel bars that were oriented along the direction of stream flow.

Wind reworked the finer sediments on the alluvial fan and the sand and gravel bars. Much of the silt and clay was blown away to become part of the Richland Loess that forms a thin blanket over the most recent glacial tills to the east. The sand was mobilized to form sand dunes. This area is the type section for the Parkland Sand.

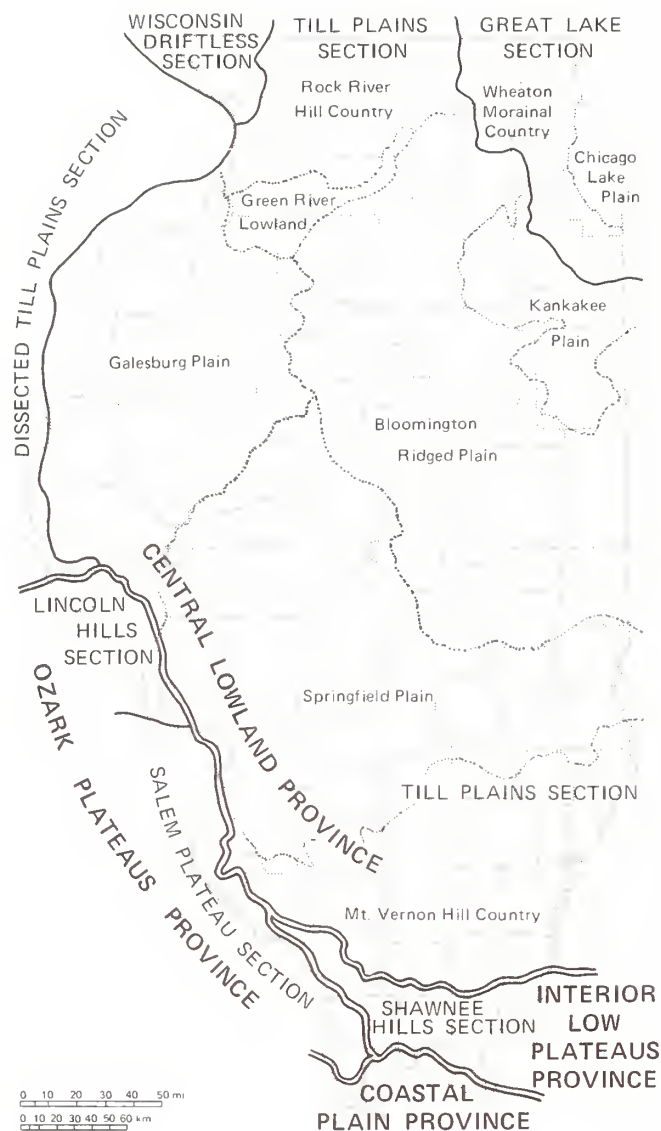
The combined actions of the Illinois and Mackinaw rivers have cut away at the alluvial fan and the sand dunes. This stream action produced three terrace levels. The highest level is the Manito Terrace. There are abundant sand dunes on the Manito Terrace. The middle level is the Havana Terrace which has scattered, small sand dunes. The lowest terrace is the Bath Terrace. Sand dunes are not present on this terrace.

The Mackinaw River has cut a broad, shallow valley into the gravels. The course of the Mackinaw River is typical of rivers cut into an alluvial fan in that the lower Mackinaw actually flows north (opposite to the direction of flow of the master stream) to join the Illinois River instead of directly to the west as is expected.

## **Geomorphology**

**Physiography** The Pekin field trip area is located at the junction between the Springfield Plain, the Galesburg Plain, and the Bloomington Ridged plain, all divisions of the *Till Plains* Section, Central Lowland Physiographic Province (fig. 11). This area is covered with a variety of glacial landforms (fig. 12). See also *Pleistocene Glaciations in Illinois* at the back of the guidebook.

According to Horberg (1950) and others (e.g., Leighton et al. 1948), an extensive lowland called the "central Illinois *penepplain*" had been eroded prior to glaciation into the relatively weak rocks of Pennsylvanian age east and south of the present-day Illinois River. Just before the advent of glaciation, an extensive system of *bedrock valleys* was deeply entrenched below the central lowland surface level. The western part of the Tazewell County upland was eroded by the ancient Mississippi River. The eastern part was eroded by ancient Mackinaw River and the Danvers River, and the southern part by the ancient Mahomet/Teays River (fig. 8). As glaciation began, streams probably changed from erosion to aggradation, that is, their channels began to build up and fill in because the streams did not have sufficient volumes of water to carry and move the increased volumes of sediment. To date there is no evidence that indicates the early fills in these preglacial valleys ever were completely flushed out of their channels by succeeding meltwater torrents.

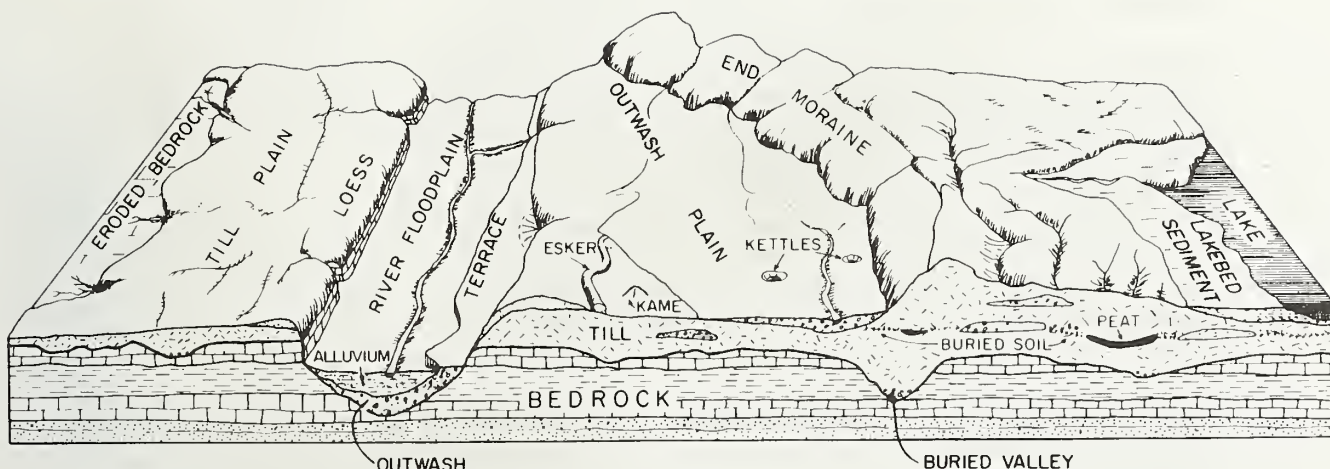


**Figure 11** Physiographic divisions of Illinois.

**Drainage** In the Tazewell County portion of this field trip area, drainage is to the west towards the Illinois River. Major tributaries to the Illinois River from the east include Farm Creek, Lick Creek, Lost Creek, and the Mackinaw River. The major tributary to the Illinois from the Peoria County portion of the field trip area is Kickapoo Creek which flows from the west. Most streams in the modern drainage system of the field trip area have medium to high gradients (bottom slopes) where they are actively eroding into the western sides of the Woodfordian moraines and streams have low gradients where they enter into the floodplain of the Illinois River. The modern courses of the Illinois River and Kickapoo Creek follow preglacial bedrock valleys.

**Relief** The highest land surface on the field trip route is south of Stop 2, where the surface elevation is slightly more than 700 feet above mean sea level (msl). The lowest elevation is about 430 feet above msl on the Illinois floodplain west of Stop 3. The surface relief of the field trip area, calculated as the difference between the highest and lowest surfaces, is about 270 feet. *Local relief* is most pronounced along the Illinois River near Stops 2 and 3 where it is greater than 200 feet.





**Figure 12** Block diagram showing relation of glacial and alluvial deposits to landforms and bedrock surface (modified from Piskin and Bergstrom 1975).

### Mineral Resources

**Mineral production** Of the 102 counties in Illinois, 98 reported *mineral* production during 1992, the last year for which complete records are available. "Complete" may be somewhat of a misnomer in that data on stone production are reported only for the odd-numbered years, and sand and gravel production data are reported for the even-numbered years. Furthermore, not all companies report their production figures and values to the U.S. Bureau of Mines. Estimates for the total stone production for 1992 (actually 1991 production) are included in the total value given for mineral production. The total value of all minerals extracted, processed, and manufactured in Illinois during 1992 was \$2,894,300,000, 0.5% lower than the 1991 total. Minerals extracted accounted for 90% of this total. Coal continued to be the leading commodity, accounting for 64% of the total, followed by industrial and construction materials at 21.4% and oil at 14.2%. The remaining 0.4% included metals, peat, and gemstones. Illinois ranked 13th among the 31 oil-producing states in 1992 and 16th among the 50 states in total production of nonfuel minerals but continues to lead all other states in production of flourspar, industrial sand, and tripoli.

Tazewell County ranked 55th among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. The only economic minerals currently mined in Tazewell County are sands and gravels. Although no coal mines are currently active the Tazewell County cumulative coal production equals 17,633,802 tons, all from the Springfield Coal. The Lakeside Coal Company, Lakeside Mine was the last active mine in Tazewell County; it closed in 1956.

**Groundwater** Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential. The availability of this mineral resource is essential for orderly economic and community development. More than 48% of the state's 11 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use.

Because thick glacial deposits occur in this area, sand and gravel deposits are common throughout most of the county. The bedrock valleys contain thick deposits of unconsolidated materials that include thick layers of sand and gravel. These sand and gravel deposits yield vast amounts of water for industrial and municipal water supplies.

## GUIDE TO THE ROUTE

Assemble near the gazebo in Mineral Springs Park, Pekin Park District (SW NE SE NE Sec. 2, T24N, R5W, 3rd P.M., Tazewell County; Pekin 7.5-Minute Quadrangle [40089E6]\*). Mileage calculations will start at the intersection of Pavilion Drive, which is in the park, and Royal Avenue, which is an east-west road north of the park.

***You must travel in the caravan.*** Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by a vehicle with flashing lights and flags, then obey the signals of the Illinois State Geological Survey (ISGS) staff directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

***Some stops on the field trip are on private property.*** The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips:

- Please do not litter or climb on fences.
- Leave all gates as you found them.
- These simple rules of courtesy also apply to public property.

If you use this booklet for a field trip with your students, youth group, or family, you must (because of trespass laws and liability constraints) get permission from property owners or their agents before entering private property.

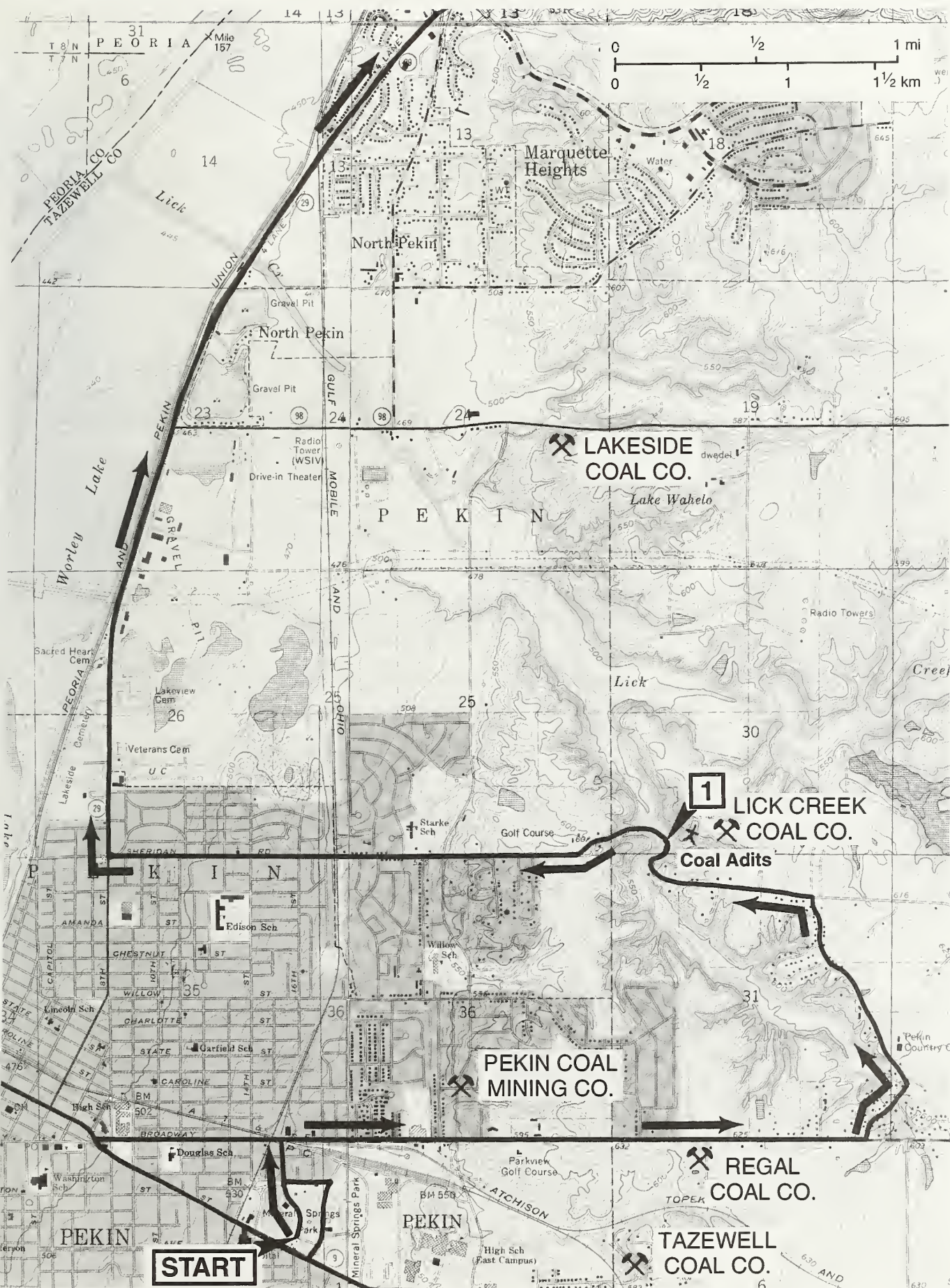
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Miles to next point	Miles from start	
0.0	0.0	STOP (2-Way): Intersection of Pavilion Drive and Royal Avenue. CONTINUE AHEAD (north) you are now on Sycamore Street.
0.15	0.15	STOP (1-Way): Intersection of Broadway and Sycamore. TURN RIGHT (east) onto Broadway.
0.4+	0.55+	CAUTION: Stoplight at intersection of Broadway and Parkway Drive. CONTINUE STRAIGHT AHEAD (east).  Abandoned Pekin Coal Company, Pekin Mine is located to the north in Sec. 36, T25N, R5W (see route map for location). This was a shaft mine in the Springfield Coal, average thickness of 56 inches at a depth of approximately 100 feet. It was operated between 1936 and 1953 and produced 900,000 tons of coal.
0.2	0.75	Parkview golf course on the right.
0.45	1.2	CAUTION: Four-lane road narrows to two-lane road.

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\* The number in brackets [40089E6] after the topographic map name is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south column from the right.





0.2	1.4	Regal Coal Company, abandoned shaft is located 360 feet to the south in Sec. 6, T24N, R4W (see route map for location). The Springfield coal averages 56 inches thick at a depth of 205 feet. Total production of coal from 1905 to 1925 was more than 237,000 tons.
		In addition, abandoned Tazewell County Coal Co., Tazewell Mine is located to the south in Sec. 6, T24N, R4W (see route map for location). This was a shaft mine in the Springfield Coal, average thickness of 56 inches at a depth of approximately 160 feet. It was operated between 1901 and 1925 and produced 2,089,332 tons of coal.
0.45	1.85	T-intersection from the left, Pin Oak Road. CONTINUE AHEAD.
0.1	1.95	T-intersection from left, Reuter Lane. CONTINUE AHEAD. Prepare to turn left.
0.05	2.0	CAUTION: T-intersection from the left (1790E and 1700N). TURN LEFT (north) into Pekin Country Club. Continue through Country Club Estates on Country Club Drive.
0.25	2.25	Cross "South Fork" of Lick Creek.
0.1	2.35	Country Club to the right. Notice the rolling topography of this area, specifically along the creek.
0.65	3.0	STOP (1-Way): T-intersection (1785N, Sheridan Road and 1770E, Country Club Drive). TURN LEFT (west) onto Sheridan Road.
0.4	3.4	CAUTION: Descend the steep valley wall of "South Fork" of Lick Creek.
0.1	3.5	CAUTION: Road takes a sharp turn to the RIGHT.
0.1	3.6	CAUTION: Another sharp turn to the RIGHT.
0.1	3.7	CAUTION: Sharp turn to the LEFT.
0.05	3.75	Cross bridge over "South Fork" of Lick Creek.
0.1	3.85	Pull over and park vehicles on the right edge of the road.

---

**STOP 1** We'll discuss the exposures of Pennsylvanian strata, including the Herrin Coal, north and south of the bridge along the west bank of the creek, and the abandoned drift mines in the Herrin Coal located north of the bridge along the east side of the creek (SE SE SW SW, Sec. 30, T25N, R4W, 3rd P.M., Tazewell County; Marquette Heights 7.5-Minute Quadrangle [40089E5]).

The property north and south of the bridge is part of Dirksen and McNaughton Park Complex, Pekin Park District. This park complex contains 1300 acres of woodland and meadows and supports about 15 species of animals, 80 species of birds, and a wide spectrum of plant life. Located along the Potawatami Trail is the "Dirksen Swimming Hole" (a spot where the late Senator Everett Dirksen swam with boyhood friends). Potawatami means 'we are making fire.' The tribe of Potawatami Indians lived in the Lick Creek bottom area from 1718 to 1837. The Potawatami Indians were allied with the Ottawa and Chippewa tribes; they called themselves the "three fires." Other tribes living in the area were the Peorias, Kickapoos, Kaskaskias, Cahokias, and Tamaroas.



The abandoned Lick Creek Coal Company, Lick Creek mine is located east of STOP 1 in Sec. 30, T25N, 4W (see route map for location). This was a slope mine in the Springfield Coal, average thickness of 60 inches at a depth of approximately 200 feet. It operated between 1940 and 1946 and produced 4,090 tons of coal.

The Herrin Coal Member of the Carbondale Formation is one of two major coals in this area. There are some 80 plus coals known from Pennsylvanian rocks throughout Illinois. The other major seam is the Springfield Coal Member of the Carbondale Formation. Over 70% of Illinois' 180 billion tons of estimated resources is found in these two widespread coal seams with over 130 billion tons being estimated for the two collectively. The Herrin Coal alone is estimated to have over 74 billion tons of resources in Illinois, some 40% of the estimated resources for the state.

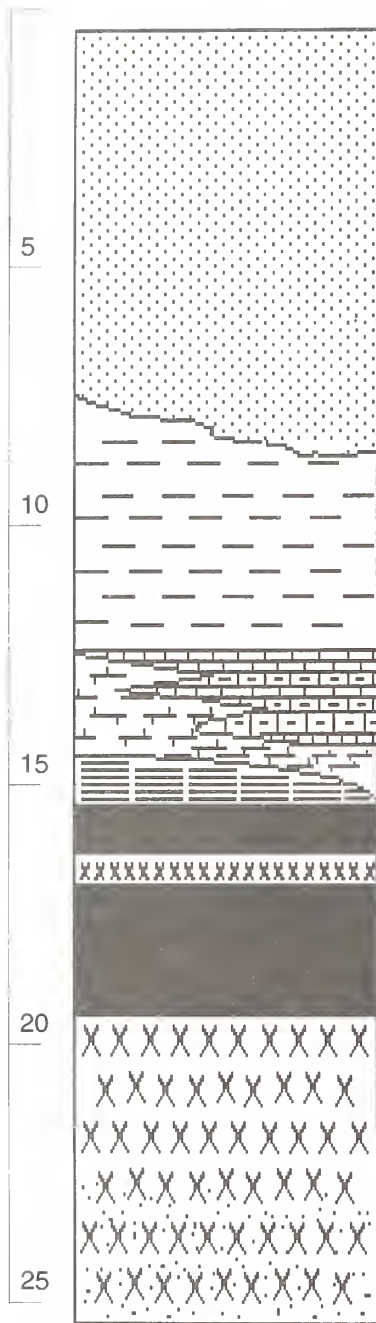
In the trip area the Herrin, Springfield, and Colchester Coals, were the main seams mined in the past. The Springfield Coal is not seen on this trip, but it lies roughly 100 feet below the Herrin Coal. At this stop we will be able to see the spoil piles from an abandoned drift mine just north of the bridge. While the opening is now collapsed, old timbers and a spoil pile of the black roof shale and coal can be seen around the opening.

The Pennsylvanian rocks exposed at this location allow us to examine strata that typify most of the Pennsylvanian in the trip area. The Pennsylvanian is made mostly of shales, claystones, and sandstone such are found in this outcrop (fig. 13). In addition, the Pennsylvanian is characterized by repetitive sequences of strata called cyclothems. (See *Depositional History of the Pennsylvanian Rocks* in the supplemental reading at the back of this guidebook for a more complete description of cyclothems.) At this stop we can see at least one cyclothem and the beginning of another. No one cyclothem contains the exact sequence of rocks illustrated in the supplemental reading (the idealized cyclothem), but we can at least see some of the typical units here: a claystone overlain by coal (the Herrin), then by black shale, limestone, gray shale and finally a sandstone (fig. 14).

The cyclothem as described in the appendix on the Pennsylvanian is a result of the retreat and advance of shallow seas across the area. In particular, the advance of the sea is marked by



**Figure 13** Exposure of Pennsylvanian strata along Lick Creek at Stop 1.



## SHELBURN FORMATION

Copperas Creek Sandstone, upper 1-2 feet more or less thin bedded, shale strongly micaceous, otherwise mostly massive appearing with iron flecks. Approximately 7 feet thick.

Shale, light blue gray, noncalcareous, fissile, thinly laminated, contains small calcareous concretions. 4-5 feet thick.

Brereton Limestone, argillaceous, gray, very fossiliferous with marine fossils grading westward to mostly calcareous shale with irregular nodular limestone grading to all calcareous shale in western most part of park.

Anna Shale, black, fissile, carbonaceous with gray splotches. .1-1 foot thick.

## CARBONDALE FORMATION

Herrin Coal, with bluish gray clay band (blue band) about 1 foot from top. 3.3-4 feet thick.

Claystone, noncalcareous, medium gray, darker in upper one-half foot below coal with root traces. 2.75 feet thick.

Claystone, calcareous, medium dark gray. 1.75 feet thick.

Claystone, sandy, light greenish gray, noncalcareous. 2.5 feet thick.

**Figure 14** Composite section of Pennsylvanian strata of Upper Carbondale and lower Shelburn Formations exposed at Stop

the limestone and black shale portion of the cyclothem. The black shale represents the maximum transgression of the sea, while the limestone represents a shallower, more oxygenated part of the marine portion of this cycle. Here, as in a number of the middle Pennsylvanian cyclothem, we can see the maximum transgression represented by the black Anna Shale, and the retreat of the sea by the overlying limestone grading upward into the gray shale. The retreat is marked by an influx of muds into the area, a result of either river delta distributary channels switching back and forth or in response to tectonic forces which cause a change in subsidence. Finally the return of deltaic sedimentation is marked by the sandstone (Copperas Creek) capping the Pennsylvanian strata in this exposure. This sandstone marks the beginning of the next "cyclothem".



At Stop 3 we will see a sequence consisting of sandstone overlain by claystone which is overlain by the Herrin Coal. The sandstone, which is not exposed at Stop 1, begins the cyclothem containing the Herrin Coal (known as the Brereton cyclothem, named after the Brereton Limestone). The Copperas Creek Sandstone, the upper sandstone at Stop 1, marks the beginning of a second cyclothem above the Brereton cyclothem, known as the Sparland Cyclothem. In addition, at Stop 3 we will see the development of a third cycle between the Brereton and Sparland cyclothem that has been called the Jamestown Cyclothem.

One of the things we would also like to have you notice between this stop and Stop 3 is the extreme variability of the strata overlying the Herrin Coal. In the short distance from the outcrop south of the bridge to the second outcrop in the higher stream cut to the west, the Brereton Limestone has all but disappeared and is marked only by a gray calcareous shale overlying the fissile black Anna Shale. Also, when we reach Stop 3, notice how the sequence above the Herrin is even more changed, with several sandstones, another coal, and the complete absence of both the Brereton Limestone and Anna Shale. This demonstrates that the deltaic depositional environments along the low coastline that was present some 290 million years ago was quite variable. We see these same relationships today in fluvial and deltaic sediments deposited along tropical coastlines.

Finally, compare the elevation of the Herrin Coal above the stream just south of the bridge to the elevation of the Herrin Coal west of the bridge along the stream as it flows towards the Illinois River. You can see that the Herrin Coal is much higher in the bank in this second exposure to the west of the bridge. What do you think accounts for this difference?

---

0.0	3.85	Leave Stop 1 and CONTINUE AHEAD (east) on Sheridan Road and ascend hill.
0.1	3.95	NOTE: Two large slumps on left-hand side of road. The slumps occur within the thick glacial material which overlies the Pennsylvanian. The steep valleys along Lick Creek contain numerous large slump features.
0.1	4.05	Leaving valley of Lick Creek.
0.25	4.3	Lick Creek Golf Course on the right-hand side.
0.1	4.4	T-intersection from left, Oak Hill Rd. Begin descent down into the Illinois River valley.
0.1+	4.5+	STOP (4-way): Intersection of Parkway Drive and Sheridan Rd. CONTINUE AHEAD (east).
0.35	4.85	Cross abandoned Gulf Mobile and Ohio Railroad (GM&O RR). The irregular topography ahead for about one mile resulted from the highest water levels of the Kankakee Torrent nearly 12,500 years ago.
0.8	5.65	CAUTION: Stoplight, intersection of Sheridan Rd. and 8th Street (SR 29). TURN RIGHT (north) onto SR 29.
1.1	6.75	Worley Lake to the left beyond the Peoria and Pekin Union Railroad (P&PU RR).
0.35	7.1	The lake to the right is the site of a former sand and gravel pit. A number of apartments and single family residences have been built around it.

0.2	7.3	CAUTION: T-intersection from the right, IL 98, 1950N. CONTINUE AHEAD (northeasterly). NOTE: On the right is another water-filled, abandoned sand and gravel pit with houses built around it.
0.5	7.8	To the right is an abandoned sand and gravel pit now turned into a swimming area with floating boat dock and sand beach.
0.1	7.9+	Crossing bridge over Lick Creek. Note the gravel bottom, during dry periods there may be no water in this portion of the creek.
0.55	8.45	Crossing small unnamed concrete lined creek.
0.6	9.05	CAUTION: Stoplight, intersection of Wesley Road and Main, entering Marquette Heights, population 3,077. CONTINUE AHEAD.
0.15	9.2	CAUTION: Intersection at LaSalle Boulevard. Entering Creve Coeur, population 5900.
0.2	9.4	CAUTION: Stoplight, Interchange for I-474 on-ramp. CONTINUE AHEAD.
0.1	9.5	Passing underneath I-474. CONTINUE AHEAD.
0.15	9.65	CAUTION: Stoplight, intersection with I-474 off ramp. CONTINUE AHEAD.
		Abandoned Phoenix Coal Company, Phoenix mine is located approximately 0.3 mile to the northeast along the eastern side of unnamed creek to the right, Sec. 7, T25N, R4W (see route map for location). This was a shaft mine in the Springfield Coal, average thickness of 52 inches at a depth of approximately 85 feet. It operated between 1901 and 1922. No production figures are available.
0.75	10.4	Creve Coeur State Park, entrance sign on left side of road.
0.1	10.5	Sign on left side of road for Creve Coeur monument.
0.4	10.9	CAUTION: Stoplight, intersection of Reusch Avenue to the right and Highland Street to the left. CONTINUE AHEAD.
0.1	11.0	Descending hill. Irregular topography on both sides of this cut.
0.5	11.5	Road takes a sharp curve to the RIGHT.
0.2	11.7	Abandoned Lake Erie Mining Company coal mine is located about 0.2 mile to the left (northeast) near the far side of the P&PU RR yards, Sec. 6, T25N, R4W (see route map for location). This was a slope mine in the Springfield Coal, average thickness of 52 inches. The slope angled 7 degrees and was over 260 feet long. It operated between 1900 and 1940, slightly less than 3.4 million tons of coal were produced from this mine.
0.2	11.9	CAUTION: Stoplight, Wesley Road from the left. CONTINUE AHEAD and prepare to turn right after light.
0.05-	11.95-	TURN RIGHT, Into parking lot, follow lead vehicles and park cars in caravan formation.



**STOP 2** We will examine and discuss one of the largest exposures of Pleistocene glacial deposits and the underlying Pennsylvanian shales and siltstones (Note: irregular section 6450 ft. from the south line and 850 ft. from the east line, Sec. 6, T25N, R4W, 3rd P.M., Tazewell County; Peoria East 7.5-Minute Quadrangle [40089F5]). This surveyed land section is an extended one; the north-south length of the section is longer than one mile. This occurs at the division between T26N and T25N. These offsets are necessary because of Earth curvature. Corrections in the land survey grid are usually made at regular intervals of about 30 miles.

At this location we have an opportunity to examine some of the typical geologic units found in exposures along the Illinois River Bluffs near Peoria (fig. 15). We will continue to discuss the Pennsylvanian bedrock that underlies the glacial cover in the area. In addition, we begin to examine the glacial sediments which play such a varied and interesting part in the history of this area, in the development of the current landscape, and as an important mineral resource such as sand and gravel.

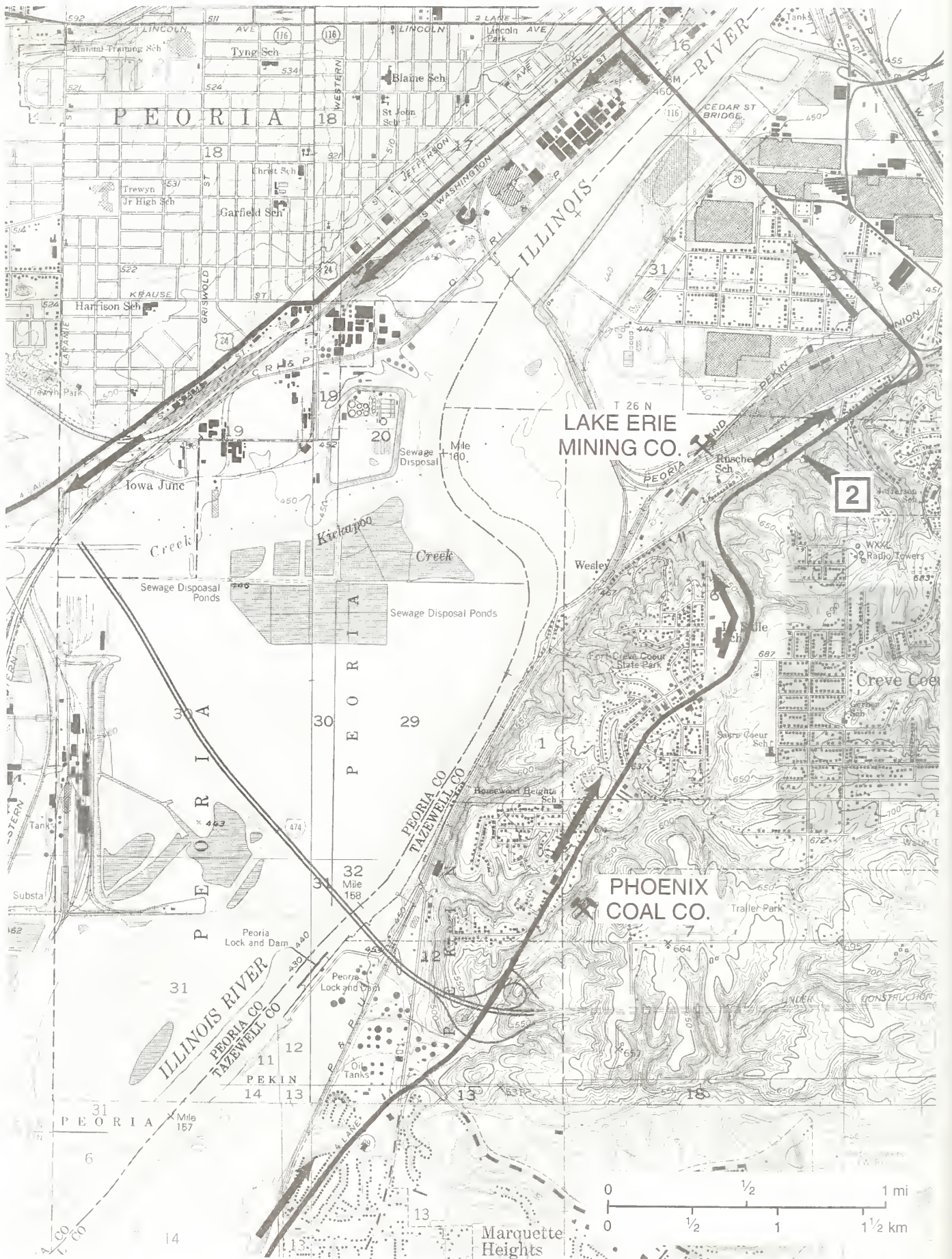
First, this stop exposes some of the typical Pennsylvanian bedrock that is usually found in the basal portion of the bluffs. At this exposure we see bluish gray shales, and siltstones from the Carbondale Formation, which occur some 20-30 feet below the Herrin Coal that we saw at Stop 1. These shales lie above the Springfield Coal, which has been mined underground just south of here and in other mines in Tazewell County. In the past, here and at many other locations in the county, the shales in the Carbondale Formation were mined as a significant resource of clays used in brick and tile manufacturing. Clay pits occur along many of the ravines and tributary valleys of the Illinois River.

Second, this location also affords our first view of some of the typical Pleistocene units found in the field trip area. Here we find glacial tills of the Illinoian Glasford Formation in the lower portion and the Wisconsinan Wedron Formation exposed in the upper portion of the Pleistocene deposits. These tills are likely the Radnor Till Member of the Glasford Formation and the Delavan/Tiskilwa Till



**Figure 15** Exposure of Pleistocene glacial deposits and underlying Pennsylvanian shales and siltstones at Stop 2.







Member of the Wedron Formation. The latter till member occurs within the Shelbyville Moraine, part of the Woodfordian-age Morainic complex (fig 16).

Measured section of strata exposed at Stop 2.

Top of Section

**Quaternary System, Pleistocene Series, Wisconsinan Stage, Woodfordian Substage, Wedron Formation, Delavan/Tiskilwa Till Member**

Till, lots of pebbles and larger fist-sized rocks, color pale yellowish brown to moderate yellowish brown (10YR 5/4). 6 feet thick.

Gravel zone, very sandy, moderate brown (5YR 4/4), sandy portion is calcareous, clayey portion is not and is pale red in color (10R 6/2). 5.83 feet thick.

Diamicton with pebbles, mostly a sandy clay with sand lenses. Dark yellowish brown (10YR 4/2), lower 2 feet contain color banding from 10YR 5/4 to 10YR 6/2, sharp contact at base. 4.5 feet thick.

Silt loam (plastic) with small pebbles up to 1 inch, 10YR 4/2. 2 feet thick.

**Note: major unconformity missing Morton, Roxana, and Sangamon Soil. (Henry Formation)**

Gravel zone, large stones up to palm size and larger in upper 0.67 feet, grades down to pebbles up to 2 inches in lower 2 feet. 3.17 feet thick.

Gravel zone, gray color with sand in lower 0.2 feet. 1.5 feet thick

Clay and sand interbedded. 1.5 feet thick

**Illinoian Stage, Jubilean Substage, Glasford Formation, Radnor Till**

Diamicton, dark yellowish brown (10YR 4/2), very pebbly with pebbles up to 3 inches, sand layer at bottom 0.25 feet thick. 6.25 feet thick.

Gray diamicton, similar to above with common intermixed sand layers. Sand is dark yellowish orange (10YR 10/6) to (10YR 5/4). Diamicton is dark yellowish brown (10YR 4/2). Grades to gray diamicton in roughly the basal 1 foot. 15.75 feet thick.

Sand layer, clayey, dark yellowish orange (10YR 6/6) to pale yellowish brown (10Y 6/2). 0.75 feet thick.

Diamicton, similar to above. 0.33 feet thick.

Sandy layer, with abundant pebbles in lower 5 feet, similar to above. 7 ft thick.

Diamicton, gray (dark yellowish brown 10YR 4/2), lots of pebbles and cobbles, 15 feet thick.

Diamicton with interbedded sand layers 1 to 2 inches thick, has mixed oxidized zones. To northwest in cut this diamicton becomes quite hard and firm. 6 feet thick.

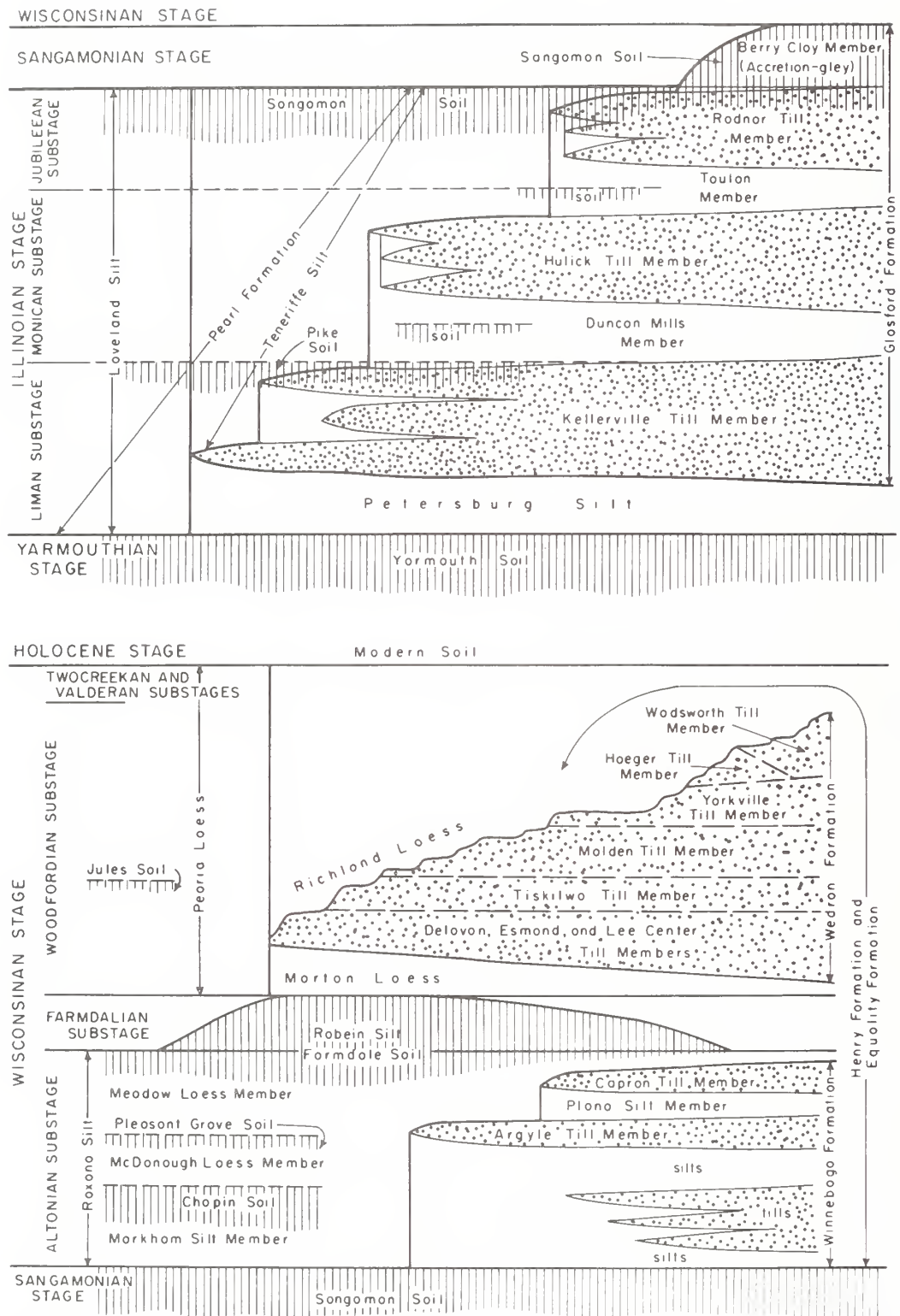
Zone of very weathered shale/till?, gray, mucky, blue gray color (light bluish gray, 5B 7/1) 1.17 feet thick. Disconformable contact with:

**Pennsylvanian System, Carbondale Formation**

Shale greenish gray, wet, clayey, contains scattered concretions in lower 12 feet, grades into unit below:

Shale, gray, micaceous, silty, with sideritic concretions along bedding planes up to 8 inches in diameter in upper 4 feet. 8 feet thick.

Base of Section



**Figure 16** Diagrammatic cross sections of Illinoian and Wisconsinan Age formations and members (from Lineback 1979).



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0.0	11.95-	Leave Stop 2. TURN RIGHT (northeast) on Route 29. Stay in right lane. NOTE: We will be taking the Cedar Street bridge across the Illinois River.
0.25	12.2	CAUTION: Entering East Peoria. PREPARE to TURN RIGHT, follow SIGNS MARKED West (IL 8 and IL 116).
0.2	12.4	TURN RIGHT onto Cedar Street Bridge access ramp. Note: Road curves to the RIGHT and then LEFT.
0.2	12.6	Good view of industrial complex on the right and left sides of road. CONTINUE AHEAD.
0.3	12.9	CAUTION: Edmund Street exit ramp. CONTINUE AHEAD.
0.5	13.4	Illinois River and entrance to Cedar Bridge.
0.3	13.7	Good view of the river and the industrial complex along the banks of the river. Usually barges can be seen from this viewpoint. Good view of the Franklin Street and Baker bridges to the north (right) and the old railroad bridge to the south (left). NOTE: Merge into the LEFT-HAND LANE as you enter the bridge.
0.4	14.1	CAUTION: Stoplight, intersection of South Washington Street (US 24), and MacArthur Highway (IL 8, 116, and 29). TURN LEFT (southwest) onto South Washington Street.
0.35	14.45	CAUTION: Stoplight, intersection of Edmond Street and South Washington St., CONTINUE AHEAD.
0.25	14.7	CAUTION: Stoplight, intersection of Cass Street and South Washington St., CONTINUE AHEAD.
0.05	14.75	CAUTION: Stoplight, intersection of South Street. CONTINUE AHEAD. Industrial complex on both sides of Washington Street as you are heading south.
0.75	15.5	CAUTION: Road jogs slightly to the RIGHT.
0.1	15.6	CAUTION: Road takes a large jog to the RIGHT.
0.1	15.7	CAUTION: Stoplight, intersection of Southwest Adams St. (3400) and Washington Street. TURN LEFT onto Adams Street.
0.2	15.9	Hubcap House on the right.
0.2	16.1	CAUTION: Stoplight, intersection of Griswold Avenue and Adams St., CONTINUE AHEAD.
0.2	16.3	CAUTION: Stoplight, intersection of Windener Street and Adams St., CONTINUE AHEAD.

0.2	16.5	Crossing bridge over Chicago, Burlington & Quincy ([CB&O] = Burlington Northern [BN]) and Chicago Rock Island and Pacific (CRI&P) railroad tracks. CONTINUE AHEAD.
0.05	16.65	Entering Bartonville and interchange with I-474. CONTINUE AHEAD.
0.15	16.8	Passing under I-474. CONTINUE AHEAD.
0.2	17.0	Cross bridge over Kickapoo Creek.
0.15	17.15	CAUTION: Stoplight, intersection of Washington Street to the left and Smithville Road to the right. CONTINUE AHEAD on US 24. We are now on McKinley Street.
0.3	17.45	CAUTION: Stoplight, intersection of McClure Street and McKinley St., CONTINUE AHEAD.
0.6	18.05	CAUTION: Stoplight, Illinois Street and McKinley Street. PREPARE TO TURN RIGHT.
0.15	18.2	CAUTION: Stoplight, TURN RIGHT on Pfeiffer Road and ascend hill. Entering the Bartonville Industrial Park. Road curves to RIGHT as you ascend hill and then LEFT. Merge into LEFT-HAND LANE. Large outcrop on the right is Stop 3.
0.35	18.55	CAUTION: T-intersection from the left, South Beckner Drive (unmarked). TURN LEFT onto South Beckner Drive and follow road to intersection of Industry Drive. TURN RIGHT onto Industry Drive.
0.4	18.95	Pull over to the right side of road and park.

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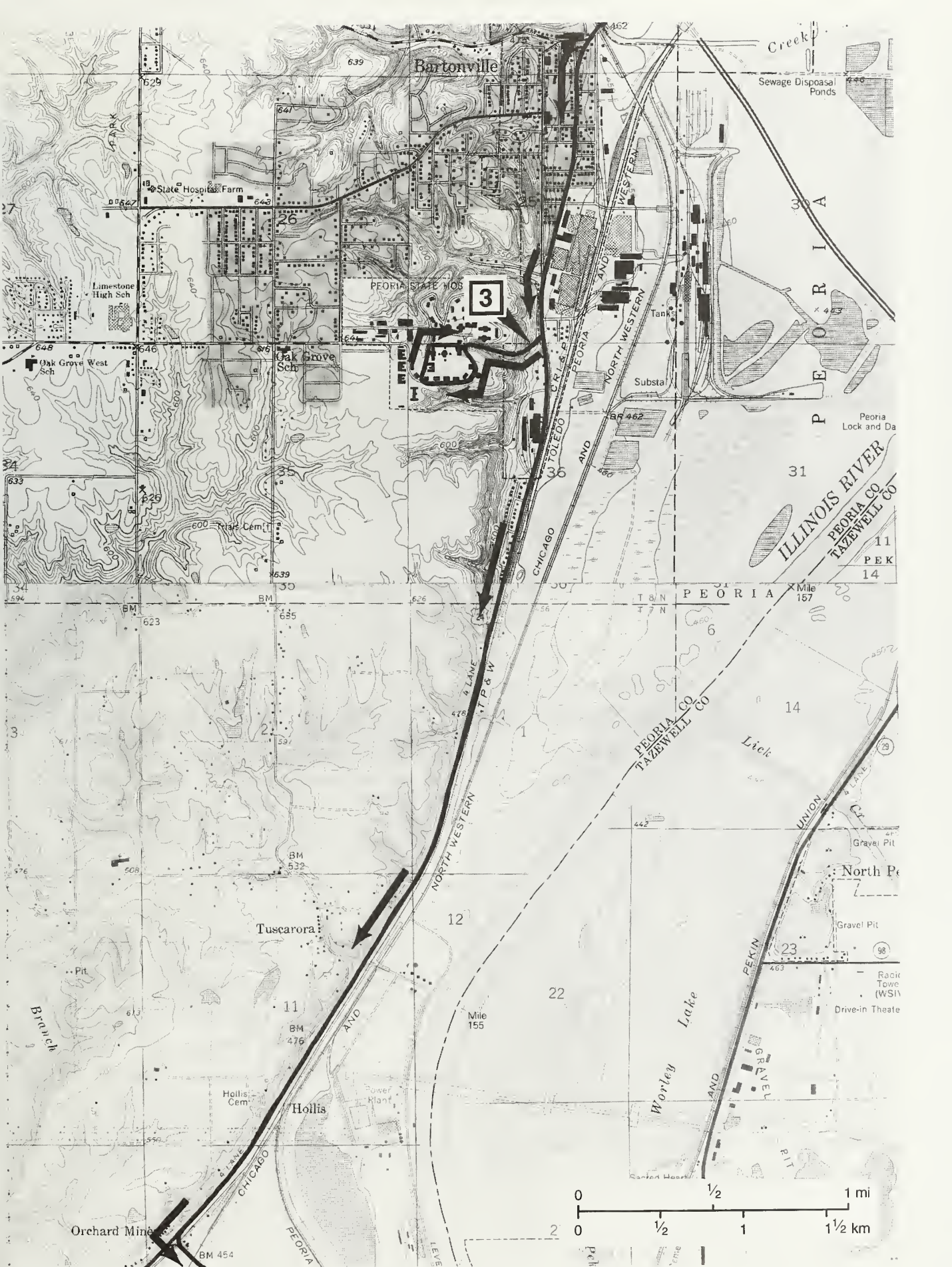
**STOP 3** Exposure of Pennsylvanian strata at the entrance to the Bartonville Industrial Park (NE NE NE NW, Sec. 36, T8N, R7E, 4th P.M., Peoria County; Peoria West 7.5-Minute Quadrangle [40089F6]).

At this stop we will make our final examination of upper Carbondale and lower Shelburn Formation rocks associated with the Herrin Coal (fig. 17). The primary purpose of this stop is to examine one of the better exposures (a recent roadcut, see fig. 18) of this interval in which the variation in the strata immediately overlying the Herrin Coal can be noted and compared to what we saw at Stop 1. The name Shelburn Formation, first used in Indiana as recently been adapted by the ISGS for use in Illinois. The name Modesto Formation, formerly used in Illinois has been abandoned.

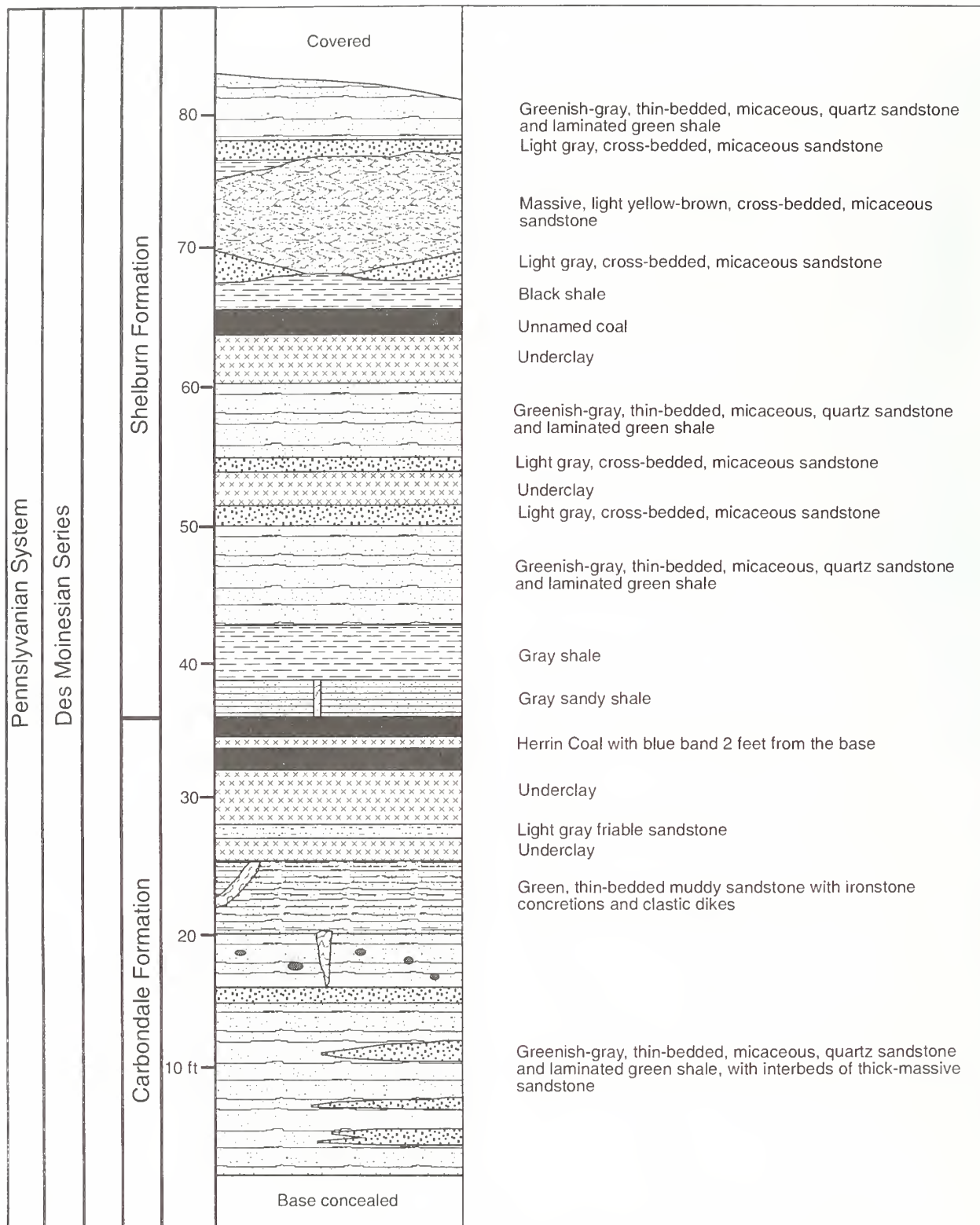
If you will remember Stop 1 and the rocks immediately overlying the Herrin Coal, what do you see here that is different? Upon closer examination you will note that the marine rocks immediately overlying the Herrin Coal are absent (both the Brereton Limestone and the black Anna Shale). In their place, in the first 10 feet over the Herrin Coal, we see sandy gray shale and gray shale. The next 20 feet of section are partially covered, but consist of thin-bedded sandstones and shales. Above this we see another coal, overlain by black shale and underlain by a typical underclay. The black shale is overlain by the massive, nearly 20-foot-thick sandstone that caps this exposure.

What has changed here? Think about our discussion of the "cycles" we see in middle and upper Pennsylvanian rocks. It appears we have two cyclothems immediately stacked on top of the one containing the Herrin Coal (the Brereton cyclothem). The one in the middle (containing the partially









**Figure 17** Composite stratigraphic column of Pennsylvanian strata in the Bartonville area, Peoria County, Stop 3.



**Figure 18** Exposure of Pennsylvanian channel sandstone at Stop 3.

covered sandstone, claystone, coal and black shale appears to have replaced (cut out) the marine sequence that we saw on the top of the Brereton cyclothem at Stop 1. Then on top of the black shale overlying this second coal, we see the return of the fluvial deltaic environment are marked by the massive sandstone deposited in a channel that was cut down into (eroded) the black shale and, in some places, even the coal.

One of the reasons for the variations we see in Pennsylvanian rocks is well illustrated here. The sandstones represent sediments filling fluvial channels of the deltas that mark the beginning of a new "cycle". These channels often cut into the previous cyclothem, sometimes eroding away much of the sediments that formed an earlier cycle. In this case, fluvial activity related to the middle cyclothem has apparently eroded the marine sediments we saw on top of the Herrin Coal at Stop 1 and left sandy gray shale in its place. Locally, both the black shale and coal of the middle cyclothem were cut out by the channel which is now filled with the massive sandstone that caps the exposure.

This type of contact between cyclothems is known as an *unconformity* because some sediment was eroded and thus an interval of sedimentation is missing. Many of the rocks in the Pennsylvanian are sandstones, shales and siltstones deposited in the fluvial-deltaic portion of the cycle. The lateral variability in strata is quite great. Thick sandstones come and go from one outcrop to another as they occur primarily in linear deposits that fill ancient river channels. Laterally, they commonly grade into the shales and siltstones that were deposited as floodplain sediments adjacent to the rivers in these constantly shifting delta systems that were present in Illinois some 290 million years ago.

In spite of the variability in the clastic units (sandstones, shales and siltstones), however, we find that many of the coals and associated claystones, black shales and limestones are much more continuous in the middle and upper Pennsylvanian across Illinois. The Herrin Coal for example, while locally cut out by sandstone-filled channels, is found over nearly the entire Illinois Basin Coal Field.

Notice that we have not named the second coal in this exposure. This in itself is an interesting story, and part of the nature of geological science. Many of the coals are readily identifiable by their spore content, which may allow us to trace coals across the basin by this characteristic feature. We also correlate many of the major seams, like the Herrin, by physically tracing them.

This second coal seam is problematic, however, as it contains some spores that resemble a coal known as the Jamestown. We would generally expect the Jamestown in this position where it is known in southwestern and eastern Illinois, but it has not previously been recognized in this area. This coal also contains spores that resemble a coal higher in the stratigraphic succession known as the Danville Coal.

Our current interpretation places this coal as slightly younger than the Jamestown, and possibly as young as the Danville Coal, given part of its spore contents. We currently cannot physically trace this coal outside of the area because several sandstones, as we see here, probably cut it out. We need to conduct further studies to determine which coal it is. If it is the Jamestown, then the upper sandstone would be (as we originally suspected) the Copperas Creek. However, if the coal proves to be younger and closer to the Danville, then the lower sandstone sequence, that is mostly covered by grass here, would most likely be the Copperas Creek Sandstone, which we saw at Stop 1.

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0.0	18.95	Leave STOP 3 and CONTINUE AHEAD.
0.1	19.05+	STOP (1-WAY): Intersection Industry Dr. and Pfeiffer Road. TURN RIGHT.
0.15	19.2	Descending hill.
0.4	19.6	CAUTION: Stoplight, intersection of McKinley Street and Pfeiffer Road. TURN RIGHT (south).
0.6	20.2	Crossing old railroad spur. To the left, three railroad tracks; Toledo/Peoria and Western Railroad (TP&W RR), CRI&P RR, and the P&PU RR. Farther to the left is another set of tracks, the Chicago and North Western Railroad (C&NW RR).
0.65	20.85	Sandstone outcrop on the right, also old cellar on right with a brick face dug into the hillside.
0.25	21.1	CAUTION: Mendahall Road to the left. CONTINUE AHEAD.
0.4	21.5	Road begins a large smooth curve to the RIGHT, merge to the LEFT LANE.
0.6	22.1	CAUTION: CILCO Lane to the LEFT. Clark Oil and Refining storage tanks on the LEFT.
0.15	22.25	CAUTION: Road from the RIGHT. CONTINUE STRAIGHT AHEAD.
0.25	22.5	Large slump on right. Old slumps along US 24 are indicated by tree trunks which are bent near the base.
0.8	23.3	CAUTION: Stoplight, intersection of IL 9 and US 24. TURN LEFT and prepare to cross bridge.

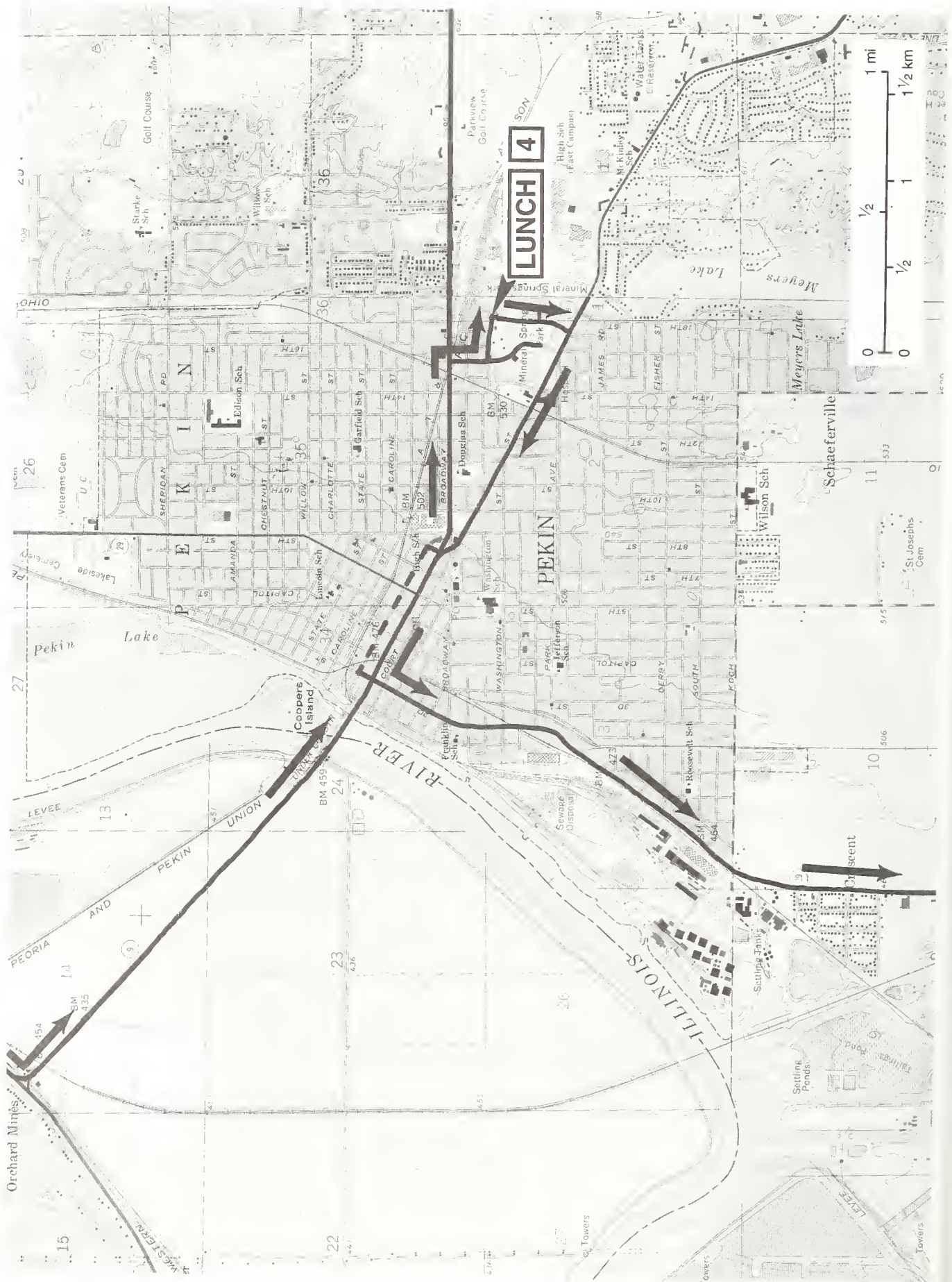


0.2	23.5	Guarded railroad crossing, C&NW RR. CONTINUE AHEAD. Crossing flood-plain of the Illinois River. As you approach the bridge you can see the manmade levees in the distance.
0.1	24.6	Entrance to John T. McNamaw bridge across the Illinois River.
0.4	25.0	Middle of the river, entering Tazewell County.
0.25	25.25	CAUTION: Stoplight, intersection of Margaret Street and 2nd Street. CONTINUE AHEAD. Pekin, population 32,300.
0.1	25.35	CAUTION: Stoplight, 3rd Street, also P&PU RR crossing, unguarded but with lights. CONTINUE AHEAD.
0.1	25.45	CAUTION: Stoplight, Capitol Street. CONTINUE AHEAD.
0.05	25.5	4th Street. CONTINUE AHEAD.
0.1	25.6	5th Street. CONTINUE AHEAD.
0.15	25.75	CAUTION: Road curves to the right. MERGE into LEFT LANE. We will be making a LEFT-HAND TURN onto Broadway at the Stoplight.
0.05	25.8	CAUTION: Stoplight, TURN LEFT onto Broadway.
0.05	25.85+	CAUTION: Stoplight, 8th Street and Broadway. CONTINUE AHEAD.
0.25	26.1	CAUTION: Stoplight, 11th Street. CONTINUE AHEAD.
0.3	26.4	CAUTION: Stoplight, 14th Street. CONTINUE AHEAD. Prepare to make RIGHT TURN onto Sycamore.
0.05	26.45	TURN RIGHT onto Sycamore Street.
0.1	26.55	STOP (2-way): Intersection of Royal Avenue and Sycamore. TURN LEFT onto Royal Avenue. Christopher from the RIGHT.
0.15	26.7	T-intersection from the left, Woodland Street. Road takes a slight jog to the right. CONTINUE AHEAD.
0.05	26.75+	Yield sign. TURN RIGHT onto Coal Car Drive.

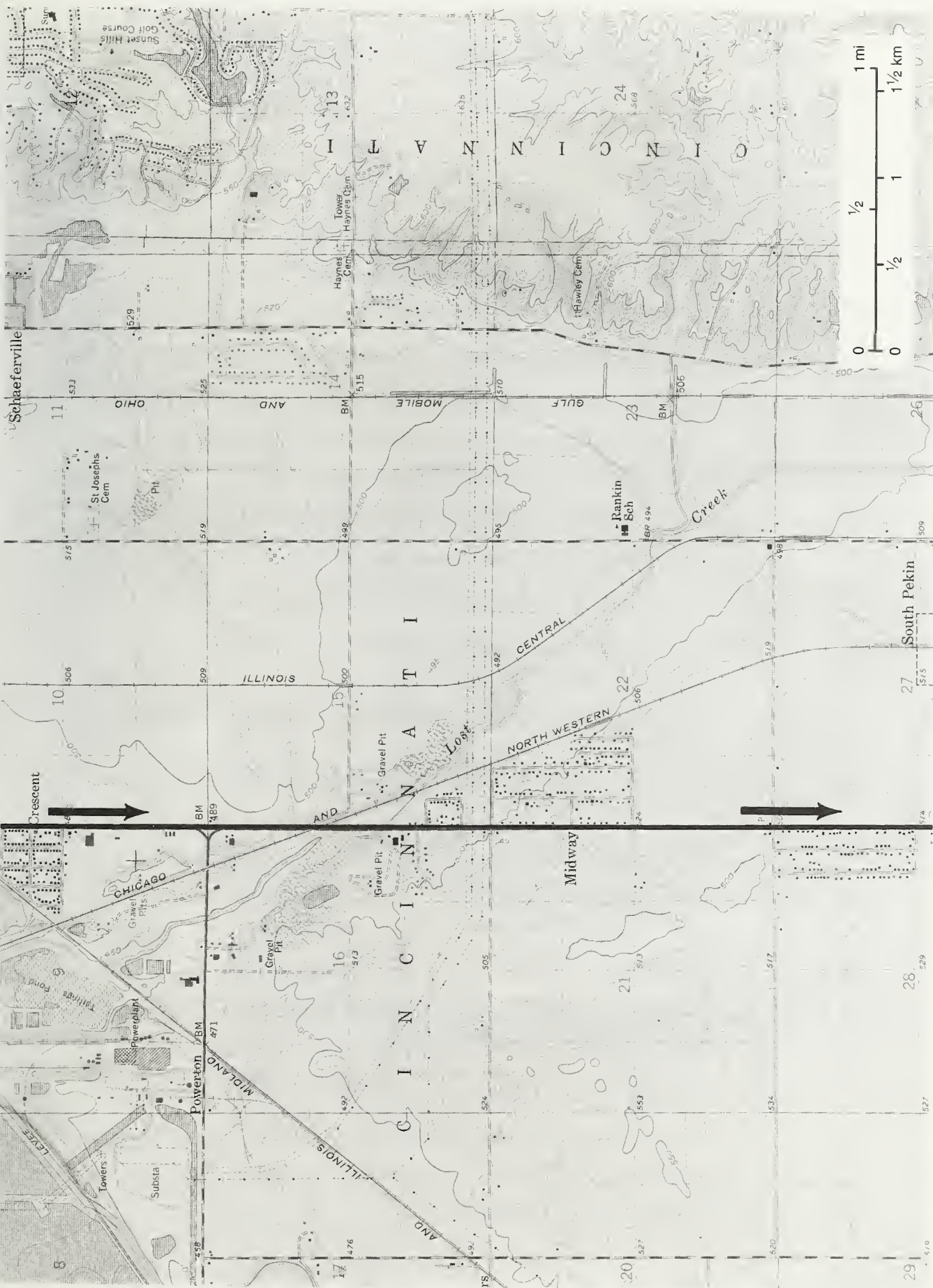
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**STOP 4 ARE YOU HUNGRY?** Lunch stop at shelter in Pekin Park at the corner of Recreation Drive and Coal Car Drive (NE SE NE NE, Sec. 2, T24N, R5W, 3rd P.M., Tazewell County; Pekin 7.5-Minute Quadrangle [40089E6]).

After lunch we will be leaving the park via Coal Car Drive heading south and we will restart our mileage at 0.0.









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Miles to next point	Miles from start	
0.0	0.0	Leave STOP 4. NOTE: Start mileage at intersection of Recreation Drive and Coal Car Drive. Head south on Coal Car Drive.
0.25	0.25	STOP (1-way): Intersection of Court Street and Coal Car Drive. TURN RIGHT (west) onto Court St.
0.2	0.45	CAUTION: Stoplight, intersection of 14th St. and Court St. CONTINUE AHEAD.
0.3	0.8	CAUTION: Stoplight, intersection of 10th St. and Court St. CONTINUE AHEAD.
0.2	1.0	CAUTION: Stoplight, intersection of 8th St. and Court St. TURN RIGHT.
0.05	1.05	CAUTION: Stoplight, intersection of Broadway, CONTINUE AHEAD and Follow IL 9 (west) on Anneliza St. Road curves to the LEFT and then heads west.
0.25	1.3	CAUTION: Stoplight, intersection of 5th and Anneliza St. Note: this is intersection of IL 29 (north) and IL 29 (south) and IL 9 (west). CONTINUE AHEAD and MERGE into LEFT lane after Stoplight.
0.2-	1.5-	CAUTION: Stoplight, intersection of Capitol St. CONTINUE AHEAD.
0.05	1.55	CAUTION: Stoplight, intersection of 3rd St. and Anneliza St. MERGE into LEFT LANE. CONTINUE AHEAD.
0.1	1.65	CAUTION: Stoplight, intersection of 2nd St. and Anneliza. TURN LEFT (south), Follow IL 29.
0.05	1.7	CAUTION: Stoplight, intersection of Margaret St. CONTINUE AHEAD, Follow IL 29. This is 2nd St.
0.3	2.0	Road curves to the LEFT.
0.2	2.2	CAUTION: MERGE RIGHT and cross unguarded single railroad track. CONTINUE AHEAD.
0.2	2.4	Road curves to RIGHT.
0.4	2.8	CAUTION: Stoplight, intersection at Derby St. and IL 29. CONTINUE AHEAD (south). To the right is Pekin Energy.  Pekin Energy is one of the largest producers of ethanol in the country and the main supplier of ethanol to Amoco.
0.3	3.1	CAUTION: intersection of Koch St. to the left and Distal Road to the right. CONTINUE AHEAD.
0.9	4.0	Approaching Manito blacktop.

0.1	4.1	CAUTION: Stoplight, intersection of Manito blacktop and IL 29. CONTINUE AHEAD.  To the left is the new Federal Correctional Institution, U.S. Dept. of Justice, Federal Bureau of Prisons.
0.4	4.5	C & NW RR underpass.
0.2+	4.7+	Cross Lost Creek.
0.4	5.1	CAUTION; Cross road intersection, unmarked. CONTINUE AHEAD.
0.3	5.4	Pivot point irrigators to the RIGHT.
0.2	5.6	T-road intersection to the LEFT. CONTINUE AHEAD.  NOTICE: Pivot point irrigation to the left and right, also view of Shelbyville/Leroy Moraine to the left.
0.5	6.1	1300E T-road intersection to the LEFT. CONTINUE STRAIGHT AHEAD.  Low hills to the right are sand dunes. These occur on the uppermost terrace called Manito.
0.5	6.6	T-road intersection to the RIGHT. CONTINUE STRAIGHT AHEAD.
0.5	7.1	CAUTION: intersection of South Pekin Road. CONTINUE AHEAD.
0.1	7.2	Crossing through a sand dune.
0.15	7.35	Pekin Municipal Airport.
0.65	8.0	CAUTION: intersection of 1100N, Townline Road. Spring Lake fishing area is to the right. CONTINUE AHEAD.
0.4	8.4	Notice the small hills to the RIGHT. These are sand dune hills. Sand dunes are developed on top of the Manito Terrace. Many of these sand dunes can be easily recognized because of the pine trees growing on top of them.
0.6	9.0	Crossroad intersection. CONTINUE AHEAD.
0.1	9.1	Road makes large curve to the LEFT.
0.2	9.3	T-intersection with road from the right 970N. CONTINUE AHEAD. Notice the large pine trees at the St. Nicholas tree farm on the left.
0.8	10.1	Crossroad intersection.
0.1	10.2	Road begins to make a large curve to the RIGHT.
0.2	10.4	Crossing Mackinaw River. The river bed of the Mackinaw contains gravel bars and is very sandy. We have dropped down onto another terrace, either the Havana Terrace or the floodplain of the Mackinaw River. Ahead of us, to

the left, is the Manito Terrace. The break between the terraces are outlined by trees which are growing on the slope between the two terraces.

1.25	11.65	Road rises and begins ascent onto the Manito Terrace.
0.35	12.0	Pull over and park vehicles on the right edge of the Road.

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**STOP 5** We will examine the glacially derived deposits of the Manito Terrace (NE SE SE SE SW, Sec. 22, T23N, R5W, 3rd P.M., Tazewell County; South Pekin 7.5-Minute Quadrangle [40089D6]).

The basal or lower deposits of the Manito Terrace consist of a combination of outwash sands and gravels from the Bloomington Moraine located to the east, and sands and gravels from the Kankakee torrent, which flowed along the path of the present Illinois River valley. These deposits are overlain by finer grained sediments consisting of windblown sands that form the sand dunes and the finer grained silts and clays that make up the loess deposits. The Manito Terrace may include deposits from the Shelbyville and Leroy moraines below those from the Bloomington Moraine and the Kankakee Torrent. However, the base of the Manito Terrace is not exposed in this area. Detailed mapping of sediments from core drilling would need to be conducted to resolve this question.

The best exposures of these deposits occur along the north-south roadcut of IL 29, and east of the railroad, along the north wall of the terrace adjacent to the east-west trending North Church St., 7000N. From this stop you can see the Shelbyville/Leroy Moraines to the east, the Mackinaw River, and the Havana and Bath terraces to the north, and the Illinois River Valley to the west.

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0.0	12.0	Leave STOP 5 and CONTINUE AHEAD (south).
0.25	12.25	As you ascend to the top of the hill, You will be on top of the Manito Terrace note the sand and gravel exposed through the soil. This is the material that is the combination of outwash and torrent deposits. At the top of the hill you can see some modern deposits of windblown sand which came from the tilled land to the west.
0.6	12.85	CAUTION: Crossing unguarded C & NW RR. Prepare to turn right.
0.25	13.1	CAUTION: intersection of IL 29, Green Valley Rd., and Toboggan Road, 600N. TURN RIGHT (west) onto Toboggan Road. Note: the village of Green Valley is located to the left.
0.1	13.2	CAUTION: Crossing Chicago and North Western Railroad tracks, unguarded. CONTINUE AHEAD.
0.55	13.75	CAUTION: Crossroad intersection, 1400E and 600N Toboggan Road. CONTINUE AHEAD. The dunes to the left have an orientation of northwest - southeast. The orientation of many of the larger sand dunes can be determined from contours on a topographical map. Look at the route map. Can you locate this or other dunes?
0.5	14.25	T-intersection from the right 1350E. CONTINUE AHEAD.
0.25	14.5	Road cuts through the middle of a sand dune. Notice sand in roadcut and the prickly pear cactus, a typical plant that grows on sand dunes. Note: as





		you pass the sand dune, another pivot point irrigation system on the left-hand side of the road. This is very common in this part of Illinois.
0.75	15.25	STOP: (2-way) Crossroad intersection of Wagonseller Road, 1250E and Toboggan Road, 600N. TURN RIGHT (north) onto Wagonseller Road, 1250E.
0.5	15.75	Road crosses another sand dune. This sand dune is oriented northeast-southwest.
0.5	16.25	T-intersection to the right. CONTINUE AHEAD.
0.25	16.5	Old sand pits. Small mining operations on both sides of road. Trees now in area where mining took place. Road descends, leaving the Manito Terrace and entering onto a small section of the Bath Terrace, followed by a gentle rise in the road which puts us on top of a small remnant of the Havana Terrace.
0.25	16.75	CAUTION: T-intersection from left, 750N and 1250E. TURN LEFT (west) onto 750N.
0.7	17.45	Road descends a gentle slope. You are leaving the Havana Terrace remnant and descending onto the top of the Bath Terrace. To the northwest is The Mound, a Manito Terrace remnant. We will be crossing The Mound in a short distance from this point.
0.6	18.05	CAUTION: Unmarked crossroad intersection, 750N and 1100E. TURN RIGHT (north) onto gravel road 1100E, before crossing the Breedlove Ditch bridge. Note again central pivot irrigation in farm fields to the left and right as you make the turn. The Breedlove Ditch is a manmade drainage ditch constructed for field drainage in this area. We are on the Bath Terrace at this point.
0.95	19.0	CAUTION: T-road from right, 850N. CONTINUE AHEAD. At this intersection the road becomes a blacktop.
0.5	19.5	CAUTION: Road curves to the LEFT. This is 900N. Tree line to the right is on a small tributary that leads into the Mackinaw River.
0.3	19.8	On the RIGHT note the manmade levee constructed along the Mackinaw River. A good view of The Mound straight ahead. The road bisects the Mound and to the left covered with pine trees is the Little Mound, a Havana Terrace remnant. Between The Mound and the Little Mound you can see the water-tower and grain elevators of the city of Manito.
0.45	20.25	CAUTION: T-road intersection from RIGHT. CONTINUE AHEAD.
0.25	20.5	Crossing bridge over Breedlove Ditch.
0.2	20.7	We are now at the top of The Mound.
0.25	20.95	CAUTION: T-road intersection from RIGHT. CONTINUE AHEAD.
0.2	21.15	Pull over and park vehicles on right side of road.

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**STOP 6** Scenic view of The Mound (fig. 19), Little Mound, and Manito Terrace (SW SW SE SW, Sec. 11, T23N, R6W, 3rd P.M., Tazewell County; South Pekin 7.5-Minute Quadrangle [40089D6]).

We will discuss the relationships between the mounds, the terraces, the Mackinaw River, the Illinois River and the Kankakee Torrent.

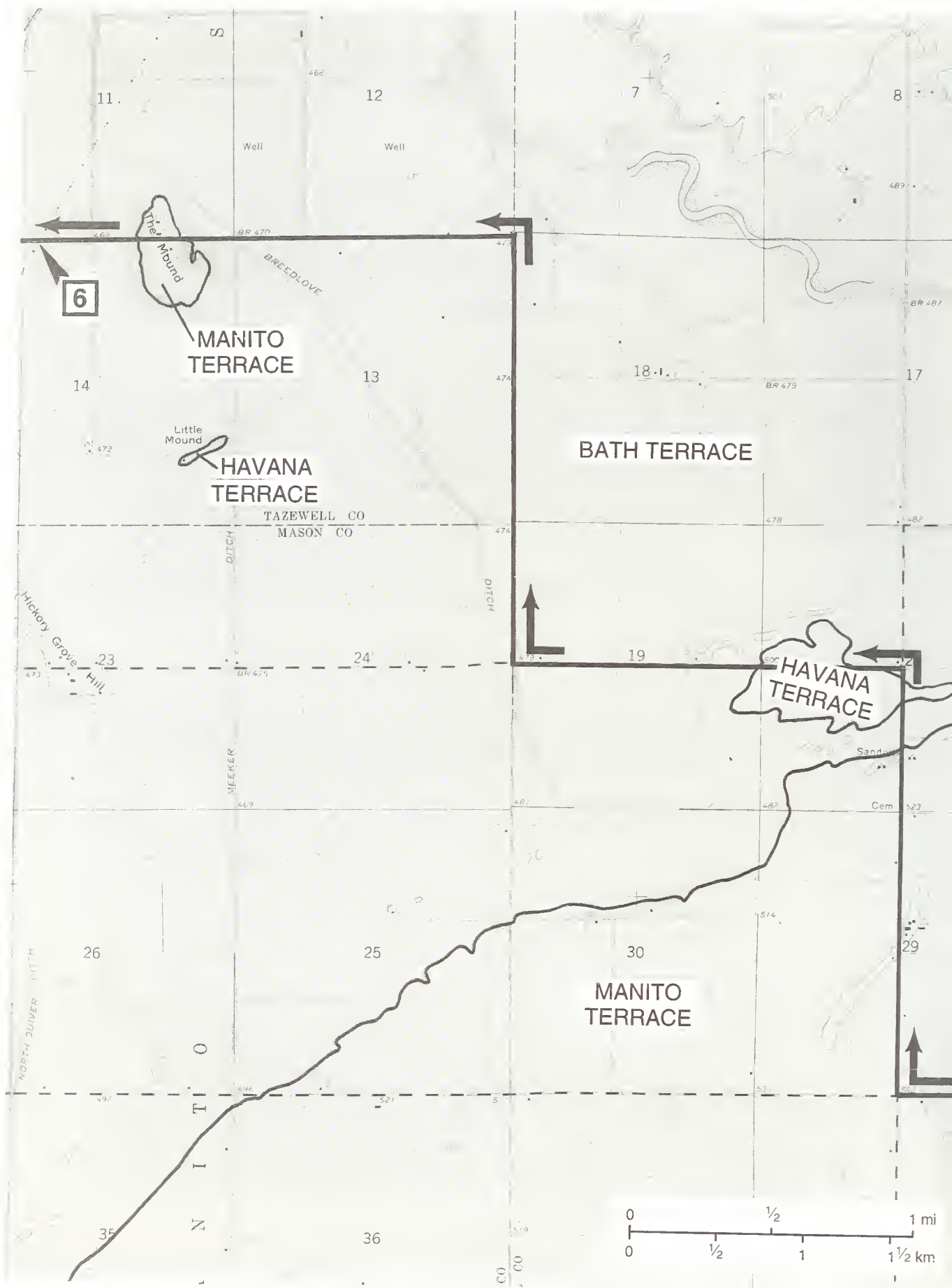
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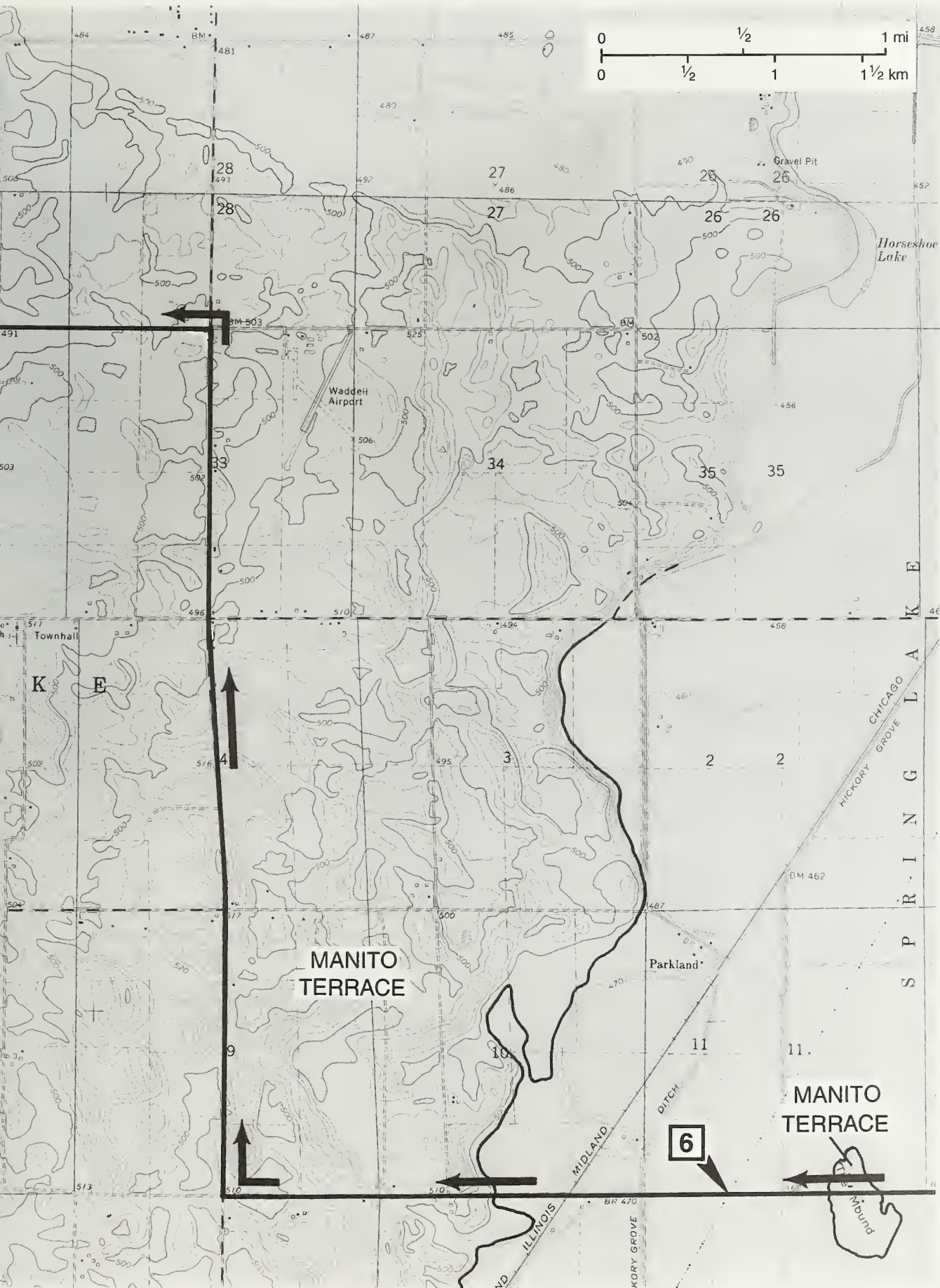
0.0	21.15	Leave STOP 6, CONTINUE AHEAD.
0.3	21.45	CAUTION: T-intersection from LEFT. CONTINUE AHEAD. Leave blacktop and enter gravel road. Cross bridge over Hickory Grove Ditch. To the right as you cross the bridge the Manito Ditch T-intersects with Hickory Grove Ditch.
0.15	21.6	Cross bridge over Manito Ditch.
0.1	21.7	CAUTION: Cross unguarded Chicago and Illinois Midland Railroad track. Rough crossing. Ballast is limestone. After crossing railroad tracks the road ascends to the top of the Manito terrace. Note: The top of the Manito is covered with sand dunes "as thick as ticks on a hound dog."
0.1	21.8	Road cuts through a sand dune. Sandy soil on right and left side of road. Note, the road is very sandy.
0.35	22.15	CAUTION: T-road intersection from RIGHT. CONTINUE AHEAD. Road is unmarked.
0.75	22.9	STOP: (2-WAY) Crossroad intersection Manito Road, 750E and 900N. TURN RIGHT (north) onto Manito blacktop.
0.7	23.6	Christmas tree farm on the right-hand side of road.
0.3	23.9	CAUTION: Crossroad intersection, Spring Lake Road, 1000N and Manito Road, 750E. CONTINUE AHEAD. To the left is Spring Lake State Park.



**Figure 19** View of The Mound from the west at Stop 6.







0.1	24.0	Crossing a sand dune. Nice view from this point of the sand dunes on the Manito terrace.
0.9	24.9	CAUTION: Crossroad intersection, Townline Road, 1100N and Manito Road, 750E. CONTINUE AHEAD.
1.0	25.9	CAUTION: Crossroad intersection (2-way stop), 1200N and Manito Road, 750E. TURN LEFT (west) onto 1200N.
0.25	26.15	Crossing another sand dune.
0.5	26.65	CAUTION: Crossroad intersection, McLaughlin Road, 675E and Airport Rd., 1200N. CONTINUE AHEAD.
0.7	27.35	CAUTION: T-road intersection from right, Bluff Rd., 600E. TURN RIGHT (north) onto 600E. Note: We are now driving along the bluff of the Illinois River.
0.55	27.9	CAUTION: T-road intersection from right. Abandoned gravel pit at base of bluff. CONTINUE AHEAD.
0.1	28.0	Road curves to the RIGHT.
0.15	28.15	View to the left. Spring Lake is at the base of the bluff and across the flood-plain is the Illinois River. From this point you can see Illinois bluffs along the north side of the Illinois River.
0.3	28.45	CAUTION: T-intersection 1300N and 620E. TURN RIGHT, follow blacktop, road curves to the right. Prepare to stop.
0.05	28.5	Pull over and park vehicles on the right side of the road.

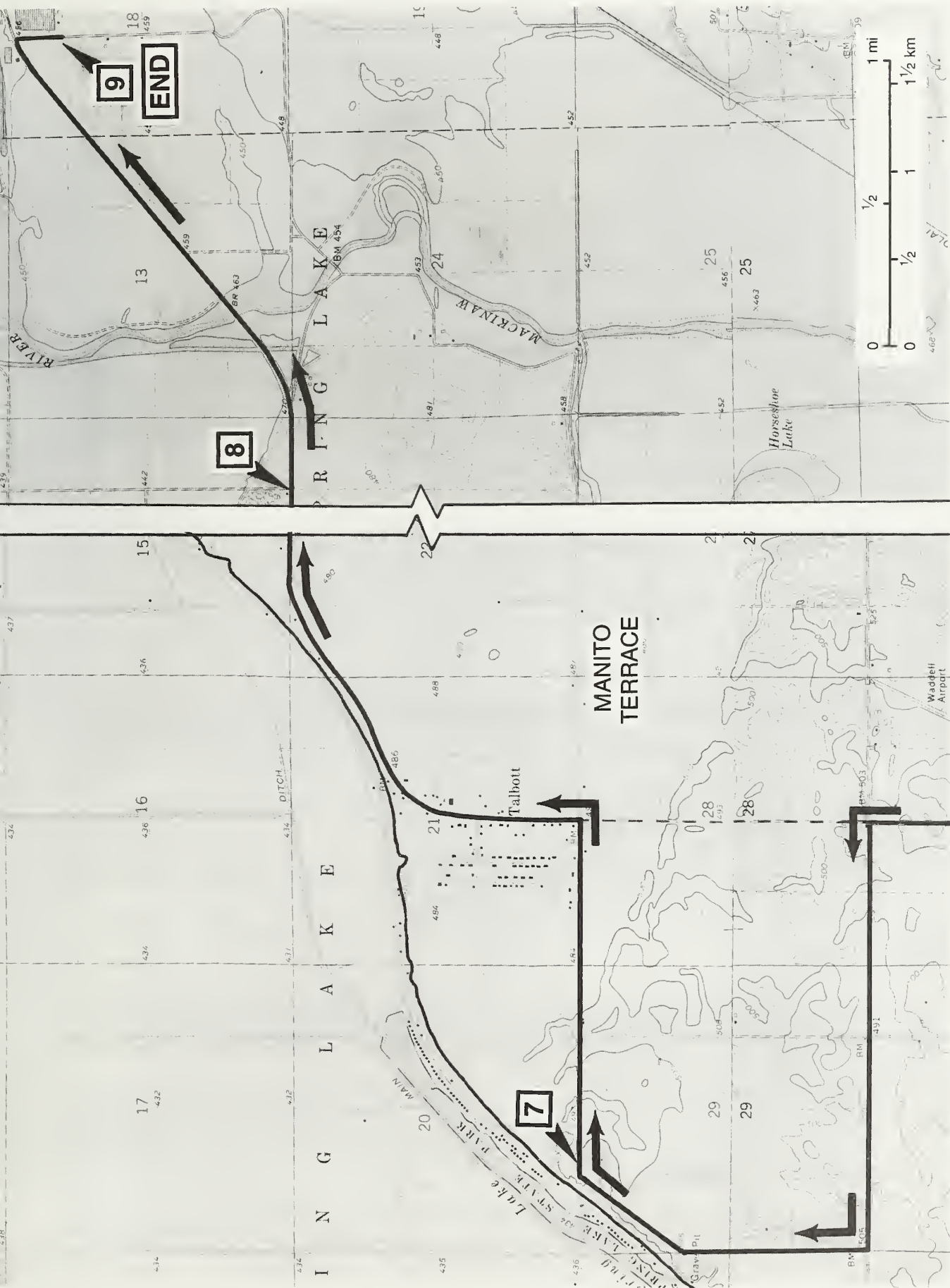
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**STOP 7** We will discuss sand dune development and examine one of the sand dunes on top of the Manito Terrace (SW SE SW, Sec. 20, T24N, R6W, 3rd P.M., Tazewell County; Glasford 7.5-Minute Quadrangle [40089E7]).

Sand dunes are abundant in the area between Pekin and Havana. These dunes are reworked glacial outwash and alluvium associated with the Kankakee Torrent (fig 20 and 21). Most of the dunes are rather old, but some have migrated out of the lowland area onto the Shelbyville Moraine. Sieve analyses of over 100 samples of sand from dunes over the entire dune field indicate that the sand is moderately well sorted, but coarser sand is present on the windward side of the dune and finer sand is present on the leeward side. There is no statistically significant difference in grain sizes between dunes located in different parts of the dune field. This indicates that the sand was locally derived everywhere in the dune field rather than blown from a single source area. Hand-auger borings encountered gravel at shallow depths (1 to 10 feet) below ground level in the inter-dune areas. Several dunes are on top of the large gravel bars produced during the Kankakee Torrent.

Because the sand and associated soils are very well drained, this area has a flora and fauna that is unusual for Illinois. Prickly Pear cactus is the most distinctive plant in the area. Pine also does well in the sandy soil. There are several pine tree plantations in the area. Lizards are common here and with care you may encounter one. Lizards may have burrowed into the dune and can be excavated by careful digging.







**Figure 20** View of sand dune on Manito Terrace at Stop 7.

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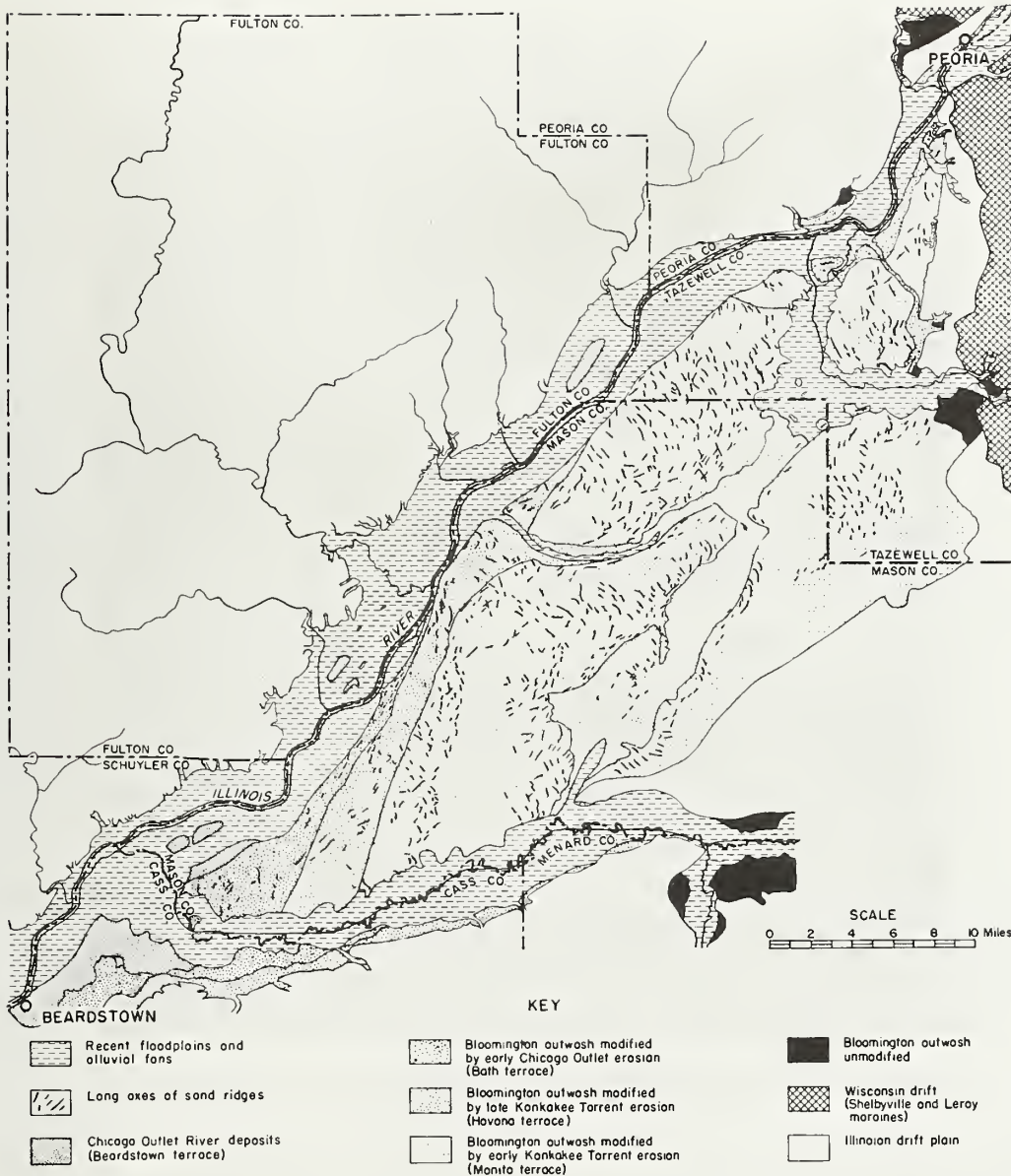
0.0	28.5	Leave STOP 7 CONTINUE AHEAD.
1.15	29.65	STOP: (2-way) Crossroad intersection, Manito Road, 750E and 1300N. TURN LEFT (north). Entering the community of Talbott.
0.4	30.05	Road curves to the right.
0.9	30.95	Wildlife prairie on the left side of the road.
0.3	31.25	CAUTION: T-intersection from the left, 850E and 1400N. CONTINUE AHEAD.
0.5	31.75	CAUTION: T-intersection from the right, 900E and 1400N. CONTINUE AHEAD. Prepare to turn left.
0.75	32.5	CAUTION: T-intersection from the left, 975E and 1400N. TURN LEFT (north) onto 975E.
0.05	32.05	Entrance to Sand and Gravel Pit, TURN LEFT, and follow lead vehicle.

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**STOP 8** Exposure of sand and gravel deposits of the Manito Terrace at the Hurley Sand and Gravel Pit, R.A. Cullinan and Sons Inc. (SE NE SW SE, Sec. 14, T24N, R6W, 3rd P.M., Tazewell County; Pekin 7.5-Minute Quadrangle [40089E6]).

At this stop we have an excellent exposure of outwash sediments in the Manito Terrace in a sand and gravel pit operation. The large cross-bed sets of sand and gravel with a west to southwest dip tell an interesting story of the history of Wisconsin glacial activity in the area some 22 to 12 thousand years ago (fig 22).

When the lobe of the Woodfordian glacier responsible for the Bloomington Morainic System pushed into the area (roughly 19,500 to 16,000 years before present) from the northeast, the associated



**Figure 21** Distribution of terraces and pattern of sand ridges in Illinois Valley from Peoria to Beardstown (from Wanless 1957).

meltwater streams carried tremendous amounts of sand and gravel into the area of the Mahomet-Teays River and Ancestral Mississippi River (now the Illinois River Valley south of Peoria). This glacial outwash was deposited as a large alluvial fan or valley train (termed the Bloomington Outwash Fan by some) that spread westward from the position of the Shelbyville and LeRoy moraines.

The Bloomington outwash fan in nearly all outcrops we see (such as this stop) shows long foreset beds of sand and gravel dipping uniformly west southwestward down the valley. Studies by Wanless (1957) show that the original surface of this valley train appears to have declined from an elevation of about 640 feet near the edge of the glacier to about 485 feet near Beardstown (fig. 23). The sediments in this outwash fan, including those later reworking by the Kankakee Torrent, collectively are termed the Mackinaw Member of the Henry Formation (fig. 16) by geologists who study them (Willman and Frye, 1970).

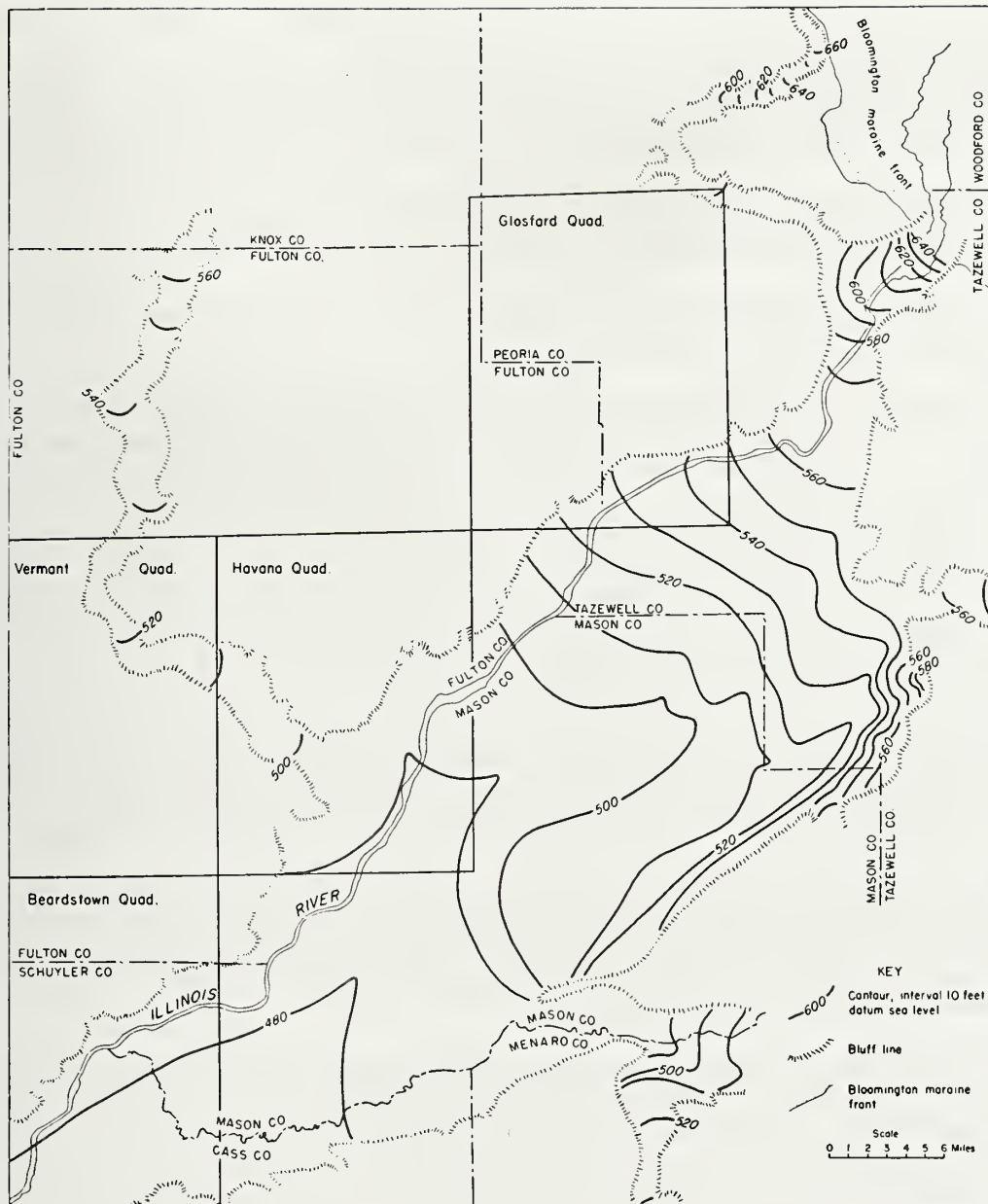




**Figure 22** View of cross bedding in sand and gravel deposits at Hurley Pit, Stop 8.

As the Woodfordian glacier later pulsed forward and melted back during the period of 16,000 to 14,000 ybp, a series of large lakes formed behind the terminal moraines left by preceding pulses of ice. During this time there appear to have been several episodes of massive flooding as the moraine dams between LaSalle and Lake Michigan were breached. These large floods are collectively called the Kankakee Torrent (Wanless, 1957; Willman and Frye, 1970). These torrents of water reworked a significant portion of the sediments of the outwash fan and created large sand and gravel bars on the upper part of this fan that were oriented along the direction of stream flow. Many of the broad terraces along the Illinois Valley we have seen today (the Manito, Havana, and Bath, for example) are largely erosional surfaces resulting from the Kankakee Torrent.

The flooding caused by periodic release of water from these lakes was substantial, leading to torrents that cut down through the unconsolidated morainic and outwash sediments into Pennsylvanian bedrock. As a result, coal and other bedrock materials were incorporated into the very coarse sediments that choked the valley just below the point of release. Besides bedrock, these torrents ripped up some of the lake sediments (laminated clayey silts) that had accumulated in the blocked river valley. As these sediments were ripped from the lake floor they were tumbled with sand and gravel to produce armored mud balls. These mud balls were deposited with the coarse sediment.



**Figure 23** Contour map showing the original form of the Bloomington valley train (from Wanless 1957).

As you examine the sediments in this sand and gravel pit you should be able to find some of the many armored clay balls of varying size coming from the upper part of the exposure. In addition, some rather large blocks of local Pennsylvanian bedrock are present from time to time, testifying to the energy unleashed during some of these large floods. At the next stop we will be able to collect some of the many pieces of local bedrock as well as glacial "erratics," rocks that originate from much farther north in Canada. The next stop also has many more of the large ripped up bedrock blocks (some approaching automobile size) that we also will be able to examine.

Near the top of this exposure (up the small road to the north) we can find sediments of another now vegetated sand dune like we examined at the previous stop. Shortly after deposition of the sand and gravel bars by the meltwater torrents, wind reworked the finer sediments from the alluvial

fan and the reworked bars. Much of the silt and clay was blown away to become part of the Richland Loess that forms a thin blanket over the most recent glacial tills to the east. The sand was mobilized to form sand dunes we have been seeing throughout much of the afternoon. This sand is named the Parkland Sand and this is the general location of the type section for this geologic unit. It was named for Parkland in Tazewell County a small town about 3 miles northeast of Manito.

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0.0	32.05	Leave STOP 8.
0.05	32.1	STOP (1-Way): T-intersection, 975E and Manito Rd., 1400N. TURN LEFT (east) onto Manito Rd.
0.35	32.45	CAUTION: Angled road intersection from the right, 1010E and 1400N, and road curves to the left. CONTINUE AHEAD. NOTE: The levees along the Mackinaw River. The Mackinaw flows into the Illinois River to your left.
0.35	32.8	Cross bridge over Mackinaw River. Notice the flood plain along the river.
1.25	34.05	CAUTION: T-intersection from the right, 1140N and 1500N. TURN RIGHT.
0.2	34.25	Entrance to Cornick Concrete Aggregate Pit.

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**STOP 9** Examination of gravel and boulders in the Manito Terrace and collection of rocks and minerals at the Cornick Sand and Gravel Pit, Cornick Concrete Products Co.(SW SW NW NE, Sec. 18, T24N, R5W, 3rd P.M., Tazewell County; Pekin 7.5-Minute Quadrangle [40089E6]).

We have several purposes for visiting this sand and gravel pit. First, we want to examine some of the large bedrock boulders ripped up by the Kankakee Torrent. This operation encounters a relatively large number of these boulders. As you look at the size of some of these blocks, try to imagine the energy of the water that could lead to blocks such as these being ripped up and deposited downstream in these sand and gravel bars.

Second, this stop affords us a good opportunity to examine and collect a large number of different types of rocks that were deposited in the alluvial fan and torrent sediments now being mined in this pit. There are many different types of igneous and metamorphic rocks, for example, that were undoubtedly brought from the north by Wisconsinan glaciers and eventually deposited in these outwash sediments as the glaciers melted. In addition, there are many smaller pieces of local Pennsylvanian bedrock that were deposited during the various phases of the Kankakee Torrent, including limestone, coal, and black shale. Some of the limestones and black shales are quite fossiliferous and will afford more fossil collecting. Finally there are also a large number of the armored mud balls in the spoil piles which will allow you to examine these unusual sediments.

Third, at this operation we will take some time to examine the equipment utilized in this sand and gravel operation. There are a number of pieces of equipment present which allow the company to sort the sediments into the precise sizes they need to meet product specifications of their customers. You may not have thought about how that gravel in your driveway was mined, or what that sand in your children's sandbox went through before you purchased it at your local hardware store.

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**END OF FIELD TRIP** We hope you enjoyed the trip and found the examination of the geology of the area around Pekin to be interesting and educational. Have a safe journey home! Join us this fall for more exciting and fun-filled adventures.



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## GLOSSARY

The following definitions are from several sources in total or in part, but the main reference is: Bates, R.L., and J.A. Jackson, eds., 1987, *Glossary of Geology*: American Geological Institute, Alexandria, VA, 3rd Ed., 788 p.

*Ablation* — Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

*Age* — An interval of geologic time; a division of an epoch.

*Aggrading stream* — One that is actively building up its channel or floodplain by being supplied with more load than it can transport.

*Alluviated valley* — One that has been at least partially filled with sand, silt, and mud by flowing water.

*Alluvium* — A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material deposited during comparatively recent time by a stream or other body of running water as a sorted or semisorted sediment in the bed of a stream or on its floodplain or delta, etc.

*Anticline* — A convex upward rock fold in which strata have been bent into an arch; the strata on each side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

*Aquifer* — A geologic formation that is water-bearing and which transmits water from one point to another

*Argillaceous* — Largely composed of clay-sized particles or clay minerals.

*Base level* — Lowest limit of subaerial erosion by running water, controlled locally and temporarily by water level at stream mouths into lakes or more generally and semipermanently into the ocean (mean sea level).

*Basement complex* — Largely crystalline igneous and/or metamorphic rocks of complex structure and distribution that underlie a sedimentary sequence.

*Basin* — A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; this also denotes an area of deeper water than found in adjacent shelf areas.

*Bed* — A naturally occurring layer of Earth material of relatively greater horizontal than vertical extent that is characterized by a change in physical properties from those overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a watercourse or of a stream channel.

*Bedrock* — The solid rock underlying the unconsolidated (non-indurated) surface materials, such as, soil, sand, gravel, glacial till, etc.

*Bedrock valley* — A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

*Braided stream* — A low gradient, low volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide, and are separated from each other by branch islands or channel bars. Such a stream may be incapable of carrying all of its load.

*Calcarenites* — Limestone composed of sand-sized grains consisting of more or less worn shell fragments or pieces of older limestone; a clastic limestone.

*Calcareous* — Containing calcium carbonate ( $\text{CaCO}_3$ ); limy.

*Calcite* — A common rock-forming mineral consisting of  $\text{CaCO}_3$ ; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs' scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

*Chert* — Silicon dioxide ( $\text{SiO}_2$ ); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint but lighter in color.

*Clastic* — Fragmental rock composed of detritus, including broken organic hard parts as well as rock substances of any sort.

**Closure** — The difference in altitude between the crest of a dome or anticline and the lowest contour that completely surrounds it.

**Columnar section** — A graphic representation in a vertical column of the sequence and stratigraphic relations of the rock units in a region.

**Conformable** — Layers of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

**Delta** — A low, nearly flat, alluvial land deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain sometimes extending beyond the general trend of the coastline.

**Detritus** — Material produced by mechanical disintegration.

**Diamicton** — A general term for unsorted, unstratified rock debris composed of a wide range of particle sizes; no suggestion about how such debris formed is implied when this term is used.

**Disconformity** — An *unconformity* marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable interval of nondeposition.

**Dolomite** — A mineral, calcium-magnesium carbonate ( $\text{Ca,Mg}[\text{CO}_3]_2$ ); applied to those sedimentary rocks that are composed largely of the mineral dolomite; it also is precipitated directly from seawater. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

**Drift** — All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

**Driftless Area** — A 10,000 square mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

**End moraine** — A ridge-like or series of ridge-like accumulations of drift built along the margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

**Epoch** — An interval of geologic time; a division of a period.

**Era** — A unit of geologic time that is next in magnitude beneath an eon; consists of two or more periods.

**Fault** — A fracture surface or zone in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on both sides relative to one another.

**Flood plain** — The surface or strip of relatively smooth land adjacent to a stream channel that has been produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

**Fluvial** — Of or pertaining to a river or rivers.

**Formation** — The basic rock unit distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types; formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), usually derived from geographic localities.

**Fossil** — Any remains or traces of an once living plant or animal specimens that are preserved in rocks (arbitrarily excludes Recent remains).

**Geology** — The study of the planet Earth. It is concerned with the origin of the planet, the material and morphology of the Earth, and its history and the processes that acted (and act) upon it to affect its historic and present forms.

**Geophysics** — Study of the Earth by quantitative physical methods.

**Glaciation** — A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

**Glacier** — A large, slow-moving mass of ice at least in part on land.



*Gradient* — A part of a surface feature of the Earth that slopes upward or downward; a slope, as of a stream channel or of a land surface.

*Igneous* — Said of a rock or mineral that solidified from molten or partly molten material, i.e., from magma.

*Indurated* — A compact rock or soil hardened by the action of pressure, cementation, and especially heat.

*Joint* — A fracture or crack in rocks along which there has been no movement of the opposing sides.

*Karst* — Area underlain by limestone having many sinkholes separated by steep ridges or irregular hills. Tunnels and caves resulting from solution by groundwater honeycomb the subsurface.

*Lacustrine* — Produced by or belonging to a lake.

*Laurasia* — A combination of Laurentia, a paleogeographic term for the Canadian Shield and its surroundings, and Eurasia. It is the protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The hypothetical supercontinent from which both were derived is Pangea. The protocontinent included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay, and geologic features on opposite sides of these zones are very similar.

*Limestone* — A sedimentary rock consisting primarily of calcium carbonate (the mineral, calcite).

*Lithify* — To change to stone, or to petrify; esp. to consolidate from a loose sediment to a solid rock.

*Lithology* — The description of rocks on the basis of color, structures, mineral composition, and grain size; the physical character of a rock.

*Local relief* — The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

*Loess* — A homogeneous, unstratified deposit of silt deposited by the wind.

*Magma* — Naturally occurring mobile rock material or fluid, generated within Earth and capable of intrusion and extrusion, from which igneous rocks are thought to have been derived through solidification and related processes.

*Meander* — One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

*Meander scars* — Crescent-shaped, concave marks along a river's floodplain that are abandoned meanders, frequently filled in with sediments and vegetation.

*Metamorphic rock* — Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust. (gneisses, schists, marbles, quartzites, etc.)

*Mineral* — A naturally formed chemical element or compound having a definite chemical composition and, usually, a characteristic crystal form.

*Moraine* — A mound, ridge, or other distinct accumulation of...glacial drift, predominantly till, deposited in a variety of topographic landforms that are independent of control by the surface on which the drift lies.

*Morphology* — The scientific study of form, and of the structures and development that influence form; term used in most sciences.

*Natural gamma log* — These logs are run in cased, uncased, air, or water-filled boreholes. Natural gamma radiation increases from the left to the right side of the log. In marine sediments, low radiation levels indicate non-argillaceous limestone, dolomite, and sandstone.

*Nonconformity* — An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

*Outwash* — Stratified drift (clay, silt, sand, gravel) that was deposited by meltwater streams in channels, deltas, outwash plains, on floodplains, and in glacial lakes.

*Outwash plain* — The surface of a broad body of outwash formed in front of a glacier.

*Oxbow lake* — A crescent-shaped lake in an abandoned bend of a river channel.

*Pangea* — A hypothetical supercontinent; supposed by many geologists to have existed at an early time in the geologic past, and to have combined all the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of some form of continental displacement. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was supposed to have split into two large fragments, *Laurasia* on the north and *Gondwana* on the south. The proto-ocean around Pangea has been termed *Panthalassa*. Other geologists, while believing in the former existence of Laurasia and Gondwana, are reluctant to concede the existence of an original Pangea; in fact, the early (Paleozoic or older) history of continental displacement remains largely undeciphered.

*Ped* — A naturally formed unit of soil structure, e.g. granule, block, crumb, or aggregate.

*Penepplain* — A land surface of regional proportions worn down by erosion to a nearly flat or broadly undulating plain.

*Period* — An interval of geologic time; a division of an era.

*Physiography* — The study and classification of the surface features of Earth on the basis of similarities in geologic structure and the history of geologic changes.

*Physiographic province (or division)* — (1) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history; (2) a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

*Radioactivity logs* — Logs of bore holes obtained through the use of gamma logging, neutron logging, or combinations of the several radioactivity logging methods.

*Relief* — (a) A term used loosely for the actual physical shape, configuration, or general unevenness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collectively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region; "high relief" has great variation; "low relief" has little variation.

*Sediment* — Solid fragmental material, either inorganic or organic, that originates from weathering of rocks and is transported by, suspended in, or deposited by air, water, or ice, or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms, and that forms in layers on Earth's surface at ordinary temperatures in a loose, unconsolidated form; e.g. sand, gravel, silt, mud, till, loess, alluvium.

*Sedimentary rock* — A rock resulting from the consolidation of loose sediment that has accumulated in layers (e.g., sandstone, siltstone, limestone).

*Sinkholes* — Small circular depressions that have formed by solution in areas underlain by soluble rocks, most commonly limestone and dolomite.

*Stage, substage* — Geologic time-rock units; the strata formed during an age or subage, respectively.

*Stratigraphy* — the study, definition, and description of major and minor natural divisions of rocks, especially the study of the form, arrangement, geographic distribution, chronologic succession, classification, correlation, and mutual relationships of rock strata.

*Stratigraphic unit* — A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

*Stratum* — A tabular or sheet-like mass, or a single and distinct layer, of homogeneous or gradational sedimentary material of any thickness, visually separable from other layers above and below by a discrete change in character of the material deposited or by a sharp physical break in deposition, or by both; a sedimentary *bed*.

*Subage* — An interval of geologic time; a division of an age.

*Syncline* — A downfold of strata which dip inward from the sides toward the axis; youngest rocks along the axis; the opposite of anticline.

*System* — the largest and fundamental geologic time-rock unit; the strata of a system were deposited during a period of geologic time.

*Tectonic* — pertaining to the global forces involved in, or the resulting structures or features of Earth's movements.

*Tectonics* — the branch of geology dealing with the broad architecture of the upper (outer) part of Earth's crust; a regional assembling of structural or deformational features, their origins, historical evolution, and mutual relations.

*Temperature-resistance log* — This log, run only in water, portrays the earth's temperature and the quality of groundwater in the well.

*Till* — Unconsolidated, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

*Till plain* — The undulating surface of low relief in the area underlain by ground moraine.

*Topography* — The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

*Unconformable* — Having the relation of an unconformity to underlying rocks and separated from them by an interruption in sedimentation, with or without any accompanying erosion of older rocks.

*Unconformity* — A surface of erosion or nondeposition that separates younger strata from older strata; most unconformities indicate intervals of time when former areas of the sea bottom were temporarily raised above sea level.

*Valley trains* — The accumulations of outwash deposited by rivers in their valleys downstream from a glacier.

*Water table* — The upper surface of a zone of saturation.

*Weathering* — The group of processes, chemical and physical, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.



ERRATICS ARE ERRATIC

*Myrna M. Killey*

You may have seen them scattered here and there in Illinois—boulders, some large, some small, lying alone or with a few companions in the corner of a field, at the edge of a road, in someone's yard, or perhaps on a courthouse lawn or schoolyard. Many of them seem out of place, like rough, alien monuments in the stoneless, grassy knolls and prairies of our state. Some—the colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks—are indeed foreign rocks, for they came from Canada and the states north of us. Others—gray and tan sedimentary rocks—are native rocks and may be no more than a few miles from their place of origin. All of these rocks are glacial boulders that were moved to their present sites by massive ice sheets that flowed across our state. If these boulders are unlike the rocks in the quarries and outcrops in the region where they are found, they are called erratics.

The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward. Hundreds of miles of such grinding, even on such hard rocks as granite, eventually rounded off the sharp edges of these passengers in the ice until they became the rounded, irregular boulders we see today. Although we do not know the precise manner in which erratics reached their present isolated sites, many were

probably dropped directly from the melting front of a glacier. Others may have been rafted to their present resting places by icebergs on ancient lakes or on the floodwaters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.



An eight-foot boulder of pink granite left by a glacier in the bed of a creek about 5 miles southwest of Alexis, Warren County, Illinois. (From ISGS Bulletin 57, 1929.)

Generally speaking, erratics found northeast of a line drawn from Freeport in Stephenson County, southward through Peoria, and then southeastward through Shelbyville to Marshall at the east edge of the state were brought in by the last glacier to enter Illinois. This glaciation, called the Wisconsinan, spread southwestward into Illinois from a center in eastern Canada, reaching our state about 75,000 years ago and (after repeated advances and retreats of the ice margin) melting from the state about 12,500 years ago. Erratics to the west or south of the great arc outlined above were brought in by a much older glacier, the Illinoian, which spread over most of the state about 300,000 to 175,000 years ago. Some erratics were brought in by even older glaciers that came from the northwest.

You may be able to locate some erratics in your neighborhood. Sometimes it is possible to tell where the rock originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from the Canadian Shield, a vast area in central and eastern Canada where rocks of Precambrian age (more than 600 million years old) are exposed at the surface. Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from a very small outcrop area near Bruce Mines, Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in the Baraboo Range of central Wisconsin. Most interesting of all are the few large boulders of Canadian tillite. Tillite is lithified (hardened into rock) glacial till deposited by a Precambrian glacier many millions of years older than the ones that invaded our state a mere few thousand years ago. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.

Many erratics are of notable size and beauty, and in parts of Illinois they are commonly used in landscaping. Some are used as monuments in courthouse squares, in parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event. Keep an eye out for erratics. There may be some of these glacial strangers in your neighborhood that would be interesting to know.



ANCIENT DUST STORMS IN ILLINOIS

*Myrna M. Killey*

Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the melt-water stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

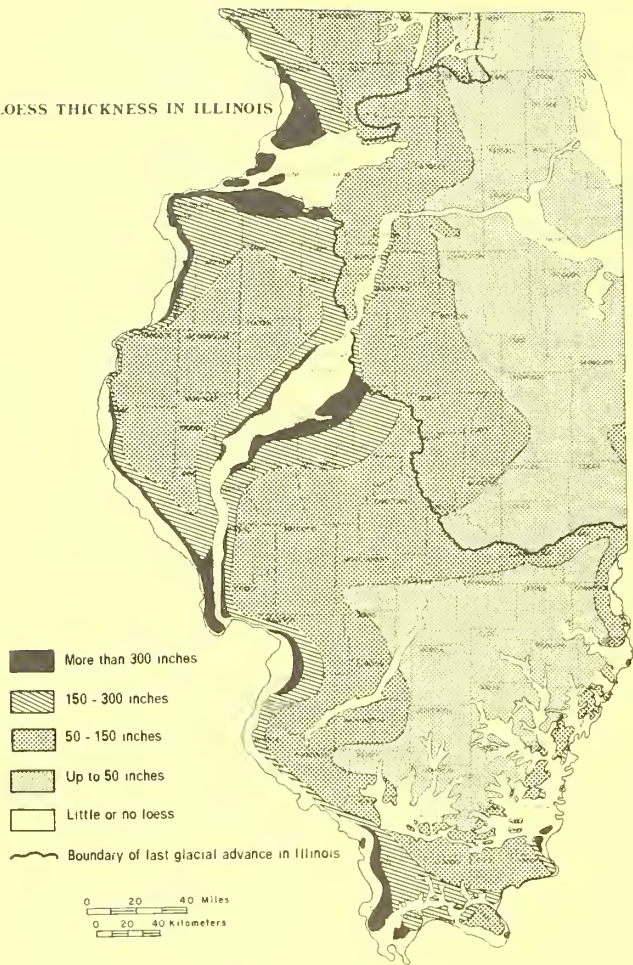
The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciaded areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny



LOESS THICKNESS IN ILLINOIS



limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material.

During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.

DO YOU LIVE ABOVE AN UNDERGROUND RIVER?

*Myrna M. Killey*

Do you think of an underground river as a hidden stream rushing through a tunnel in solid rock? Such subterranean rivers do exist in some states—in Alabama and Missouri, for example. In Illinois, however, except in a few areas where water flows through cracks and channels it has created by dissolving the limestone bedrock, underground "rivers" are not really rivers at all. The Mahomet "river" that underlies part of east-central Illinois is a good example. So is the eastern part of this "river," which is called the Teays (rhymes with "days"). Such rivers are vital to many towns, for they are a reliable source of water.

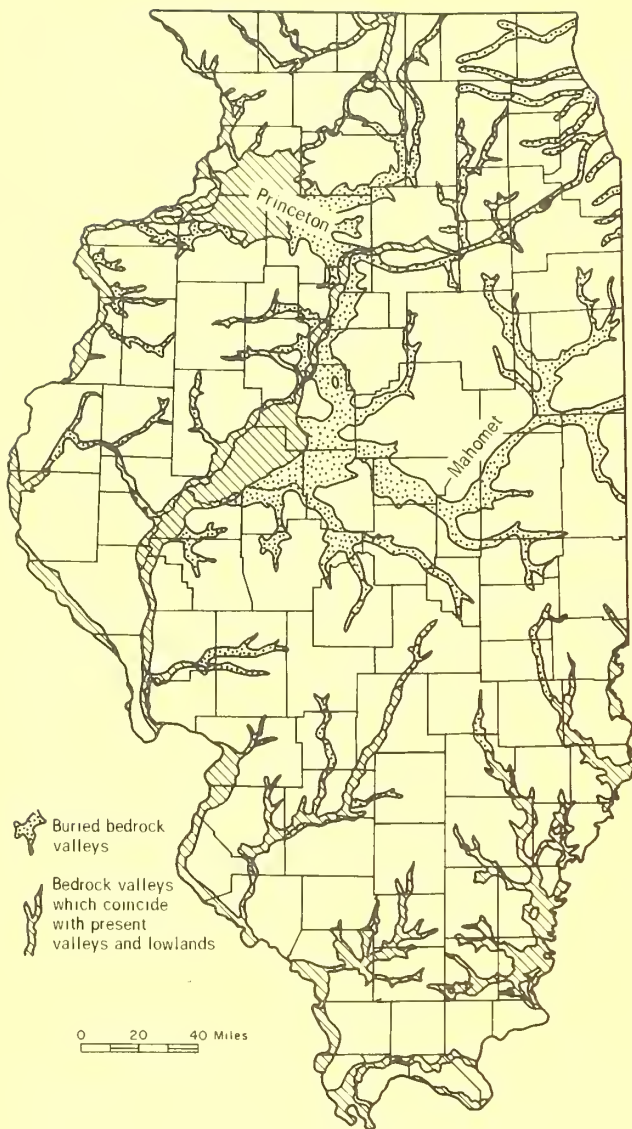
The Mahomet-Teays river system was discovered more than 25 years ago when numerous water wells were drilled in the eastern and midwestern United States. The story of this vast river system has been pieced together largely from information obtained from records made during the drilling of the wells.

More than a million years ago, before the glaciers of the Great Ice Age crept down over the Midwest, a river as large as the present Mississippi flowed generally westward from its probable source in the mountains of West Virginia, crossed Ohio and Indiana, and traversed east-central Illinois from Hoopeston to Havana. At Havana it joined another ancient river system that occupied what is now the Illinois River Valley (see map). All along its course it cut a deep valley in the bedrock.

When the successive glaciers invaded Illinois from Canada, the fringes of the ice melted during the warmer periods, and the water (meltwater) carried with it great quantities of sand and gravel that had been embedded in the ice. This material, called *outwash*, was deposited in thick layers in the Mahomet Valley. As the later glaciers advanced southward, both the valley and its outwash were buried by ice. When the ice finally melted, tremendous amounts of unsorted rock debris (pebbly, sandy clay called *till*) that had been held in the ice blanketed the land surface, including the former river valley, to depths of 50 to more than 100 feet. (The outwash and till deposits are collectively called *drift*.) The great Mahomet River Valley was obliterated from the landscape and the river no longer existed. Instead, on the new land surface the river patterns we know today developed.

The buried Mahomet Valley is invaluable to east-central Illinois because its porous sand and gravel deposits act as vast underground sponges, storing the rainwater that seeps downward from the land surface. Water flows easily through the sand and gravel into wells drilled in the porous materials. In contrast, glacial till is too fine-grained to allow the water it holds to flow easily and, therefore, cannot supply large amounts of water to wells. Towns such as Hoopeston, Champaign-Urbana, Mahomet, Monticello, and Clinton that are situated above the buried Mahomet Valley have large ground-water supplies available to them, but towns away from the valley have more difficulty obtaining their water. Perhaps the term "underground river" is still applied to the Mahomet Valley because it is easier to imagine great volumes of well water coming from a river than from beds of sand and gravel in a buried valley.





The Mahomet Valley has been traced for about 150 miles across Illinois, it lies at an average depth of more than 200 feet below land surface, and its bottom is at an average elevation of 350 feet above sea level. In some places the ancient valley varies in width from 5 miles at the Indiana line to almost 10 miles near Clinton in De Witt County.

Another major "underground river" is the Princeton Bedrock Valley in the north-central part of Illinois. Many smaller bedrock valleys in the state contain sand and gravel deposited by glacial meltwater. The Mississippi, Illinois, Kaskaskia, and Wabash Rivers also contain beds of outwash deposited by glacial meltwaters, but their courses were not obliterated by the glaciers, and their valleys have remained open as drainageways.

The water supplies in these deposits in the ancient river valleys of Illinois are one of many resources contributing to the state's natural wealth. Of the 3.3 billion gallons of water a day used by Illinois, about 450 million gallons are pumped from sand and gravel deposits, mainly of glacial origin. The value of ground water from these deposits is over \$115 million per year.

Do you live above an underground "river"? Look at the map and see. Locate the source of the water you use in your town. If you should see a well being drilled, stop and ask if you can look at the earth materials brought up from the well. These are the kinds of material used to interpret the geologic history of Illinois.



# PLEISTOCENE GLACIATIONS IN ILLINOIS

## Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.



The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

## Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

## Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.



## Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

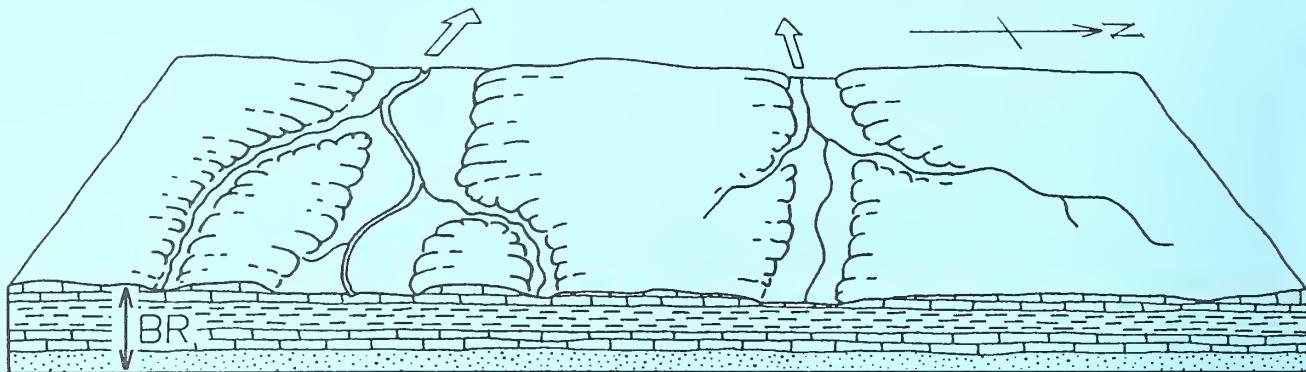
Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

## Glaciation in a Small Illinois Region

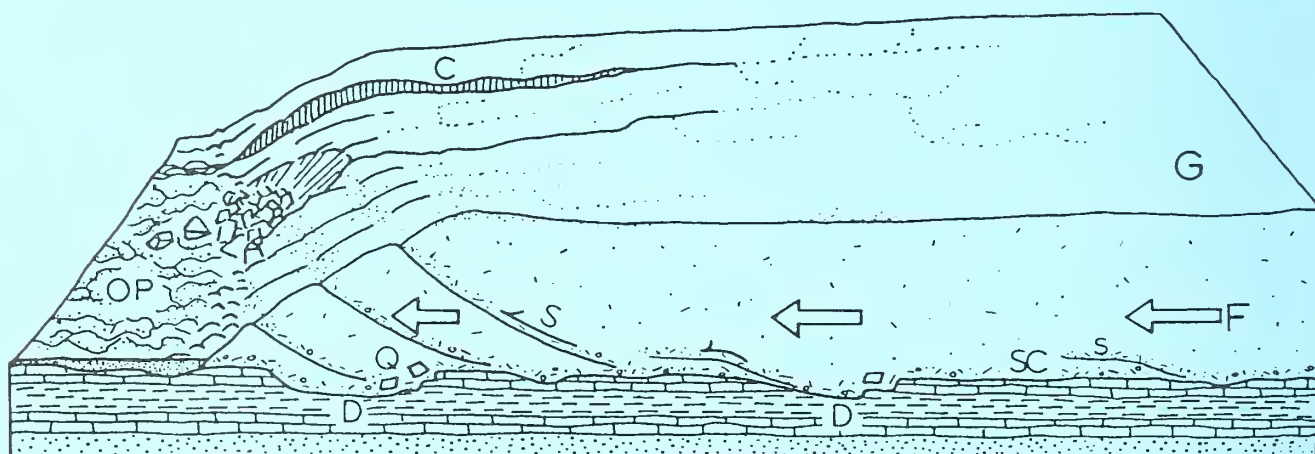
The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.

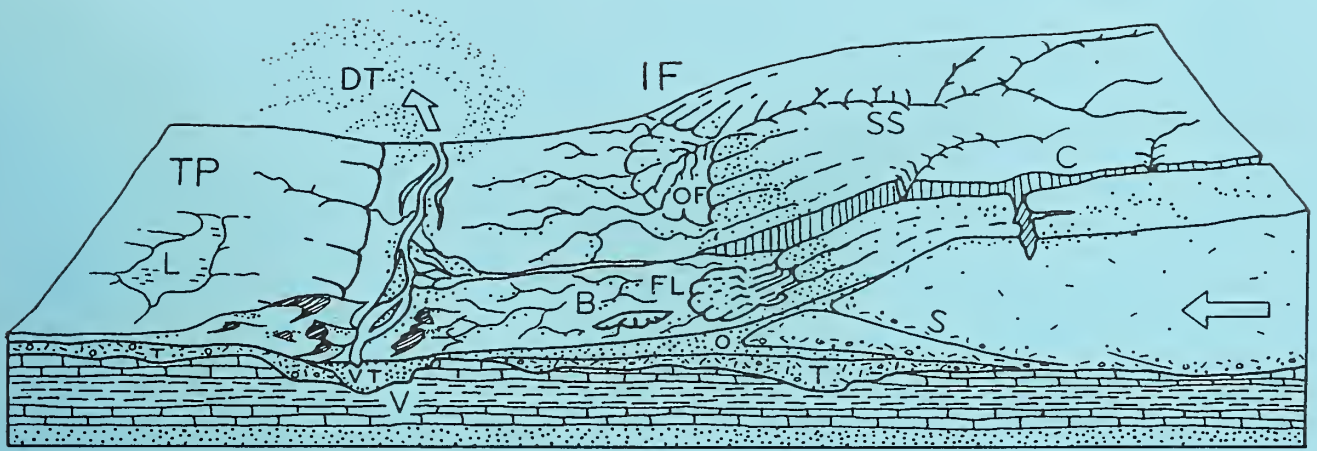




1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone (.....), limestone (— — —), and shale (≡≡≡). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



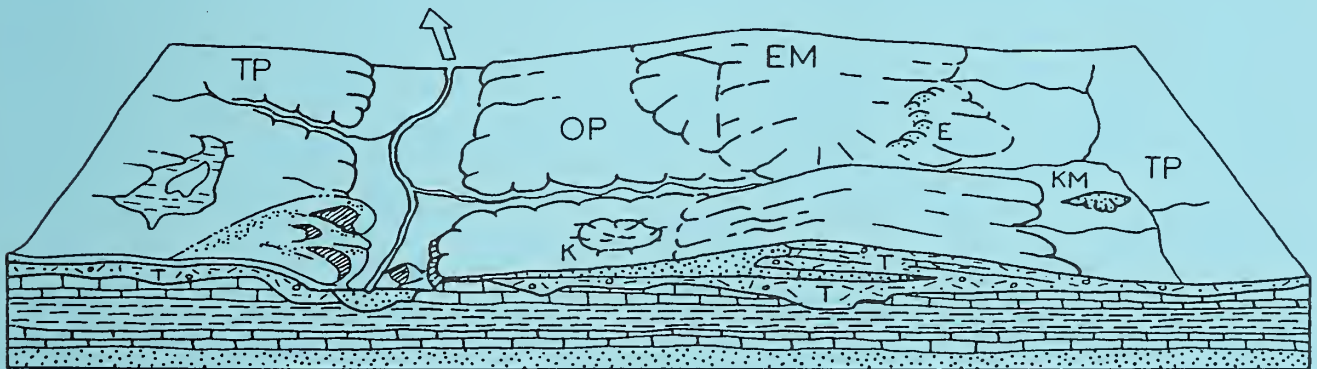
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



**3. The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



**4. The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

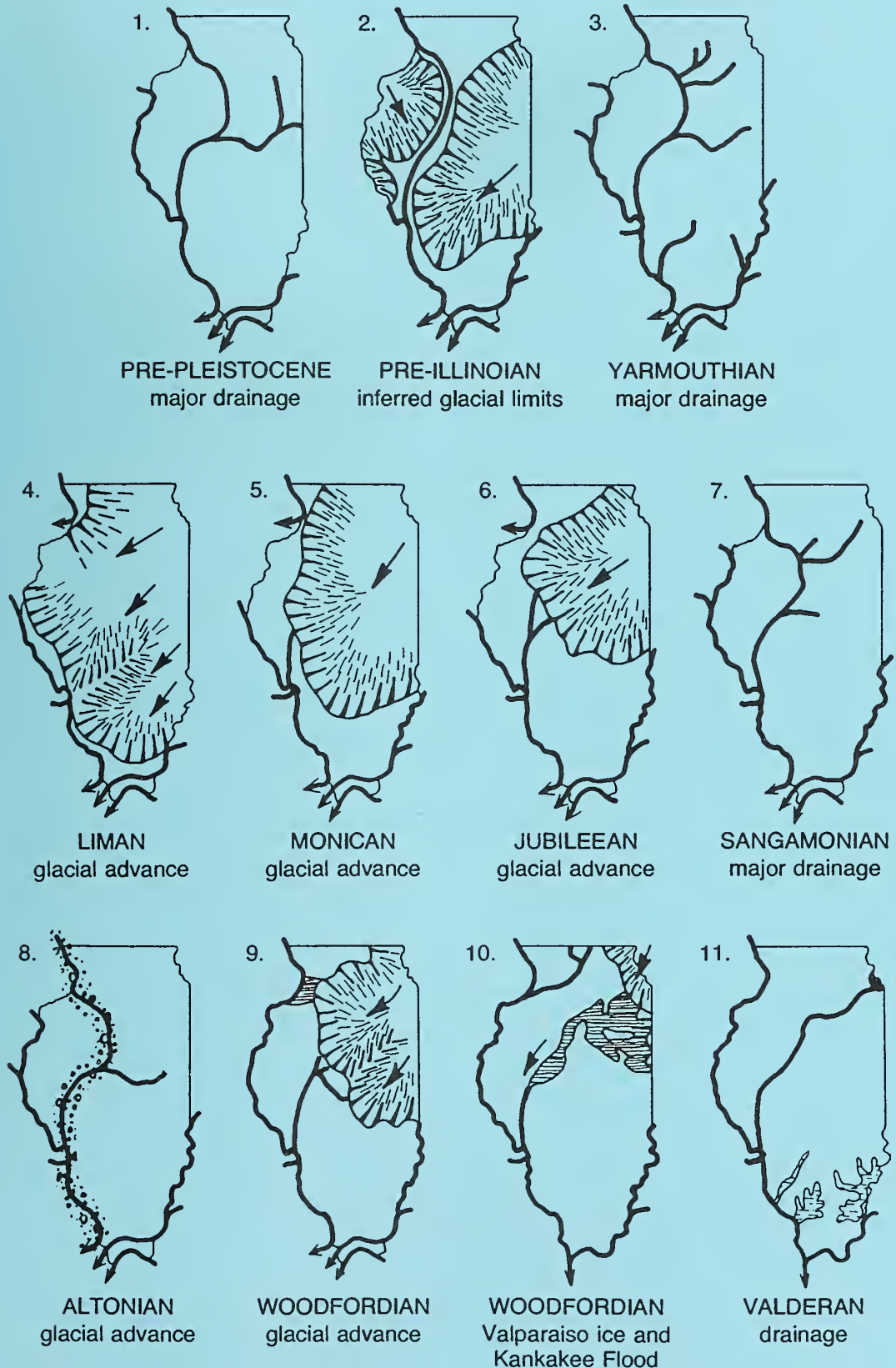
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY	Pleistocene	HOLOCENE (interglacial)	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
		WISCONSINAN (glacial)	10,000	Outwash, lake deposits	Outwash along Mississippi Valley
			Valderan		
			11,000	Peat and alluvium	Ice withdrawal, erosion
			Twocreekan		
			12,500	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
			Woodfordian		
			25,000		
			Farmdalian		
			28,000	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
		Altonian			
		75,000	Soil, mature profile of weathering	Important stratigraphic marker	
		SANGAMONIAN (interglacial)			
		ILLINOIAN (glacial)	125,000	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
			Jubileean		
	Monican				
Pre-Illinoian	YARMOUTHIAN (interglacial)	Liman	Drift, loess, outwash		
		300,000?	Soil, mature profile of weathering	Important stratigraphic marker	
		500,000?			
	KANSAN* (glacial)	700,000?	Drift, loess	Glaciers from northeast and northwest covered much of state	
	AFTONIAN* (interglacial)	900,000?	Soil, mature profile of weathering	(hypothetical)	
	NEBRASKAN* (glacial)	1,600,000 or more	Drift (little known)	Glaciers from northwest invaded western Illinois	

\*Old oversimplified concepts, now known to represent a series of glacial cycles.



# SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

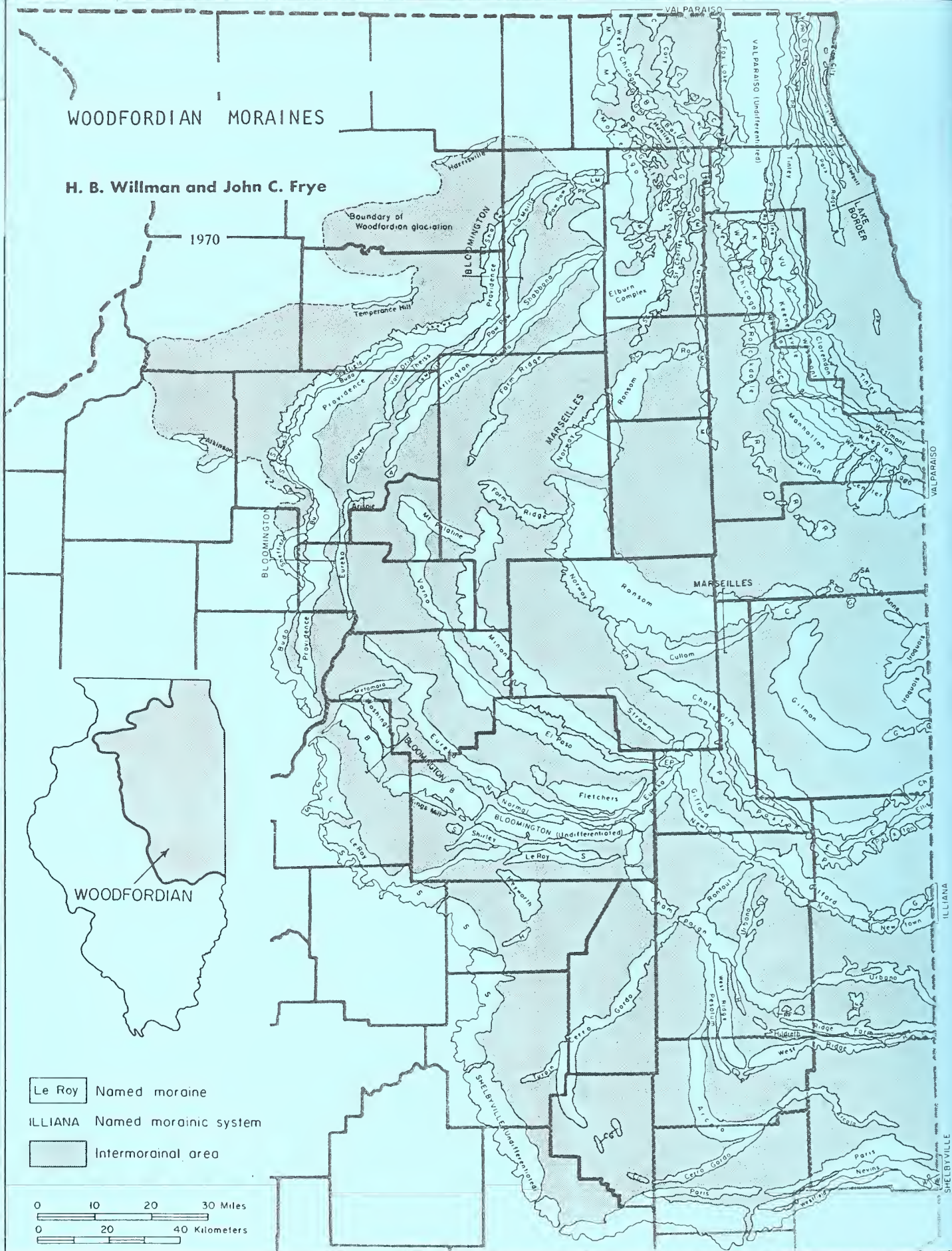
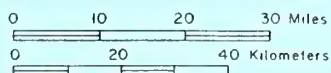
# WOODFORDIAN MORAINES

H. B. Willman and John C. Frye

1970



- Le Roy Named moraine
- ILLIANA Named morainic system
- Intermorainal area





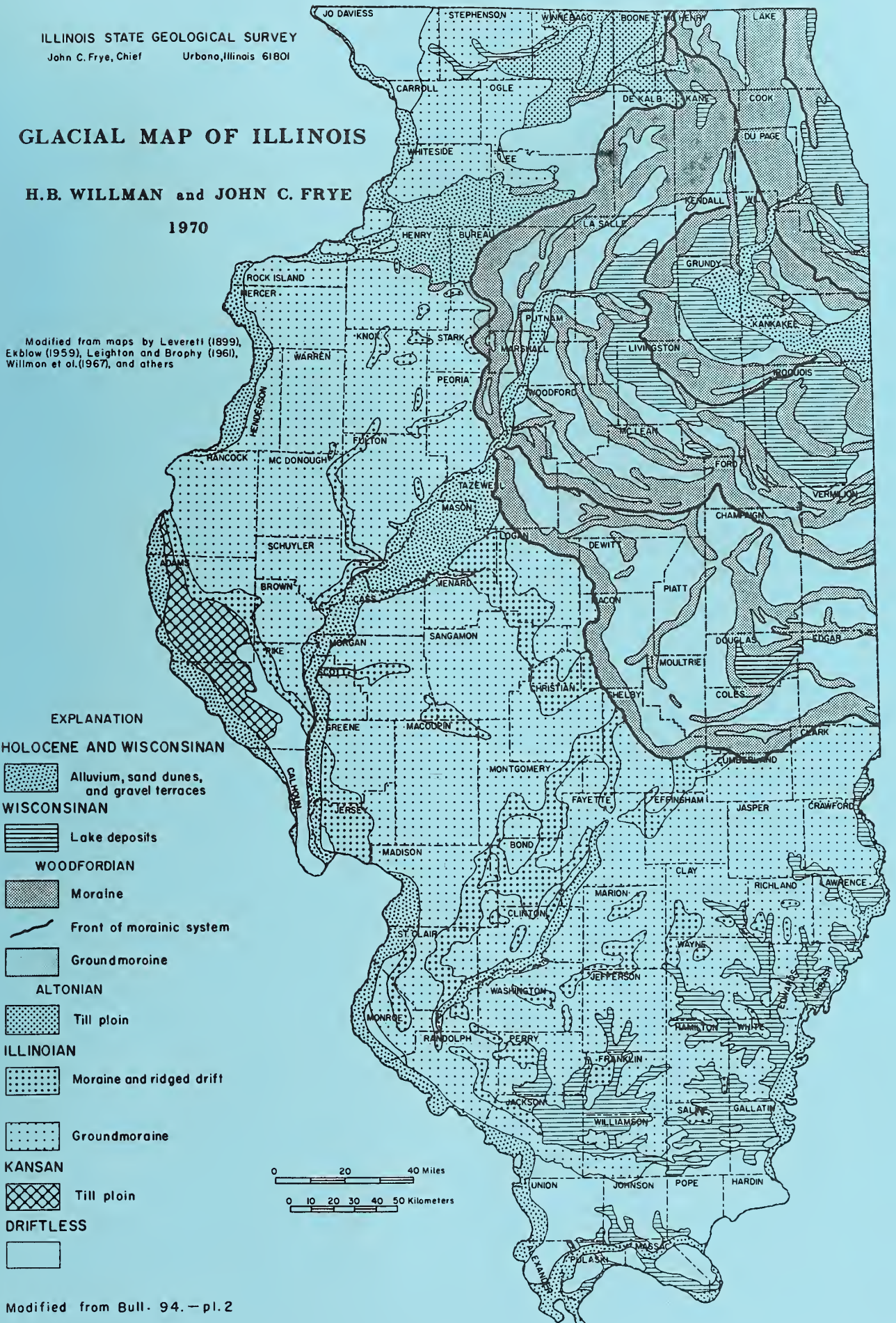
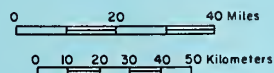
# GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willmon et al. (1967), and others

- EXPLANATION**
- HOLOCENE AND WISCONSINAN**
-  Alluvium, sand dunes, and gravel terraces
  -  Lake deposits
- WISCONSINAN**
-  Lake deposits
- WOODFORDIAN**
-  Moraine
  -  Front of morainic system
  -  Ground moraine
- ALTONIAN**
-  Till plain
- ILLINOIAN**
-  Moraine and ridged drift
  -  Ground moraine
- KANSAN**
-  Till plain
- DRIFTLESS**
- 



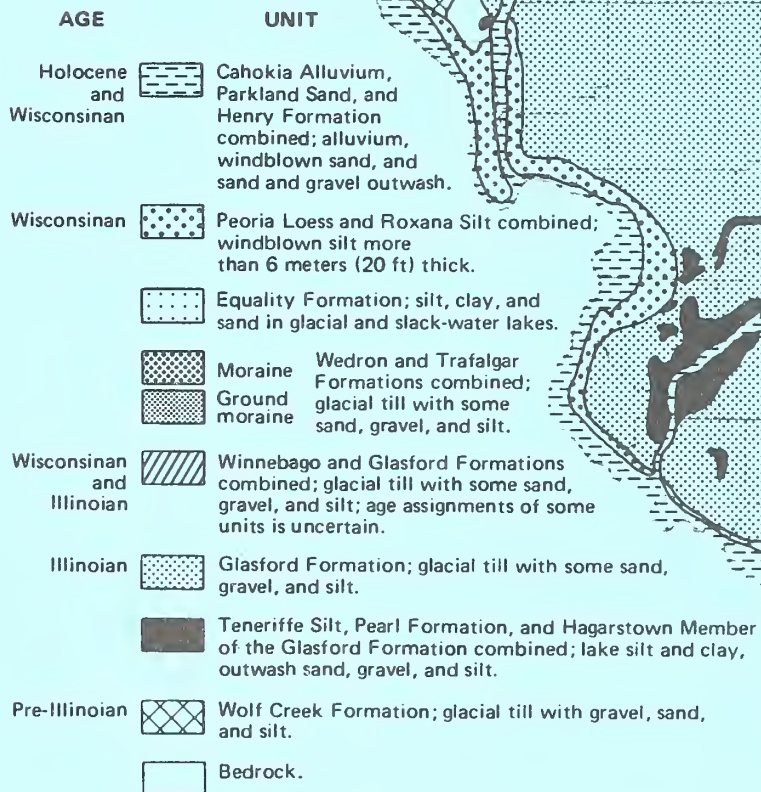
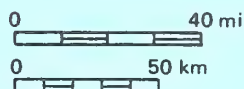


# QUATERNARY DEPOSITS OF ILLINOIS

Jerry A. Lineback

1981

Modified from Quaternary Deposits  
of Illinois (1979) by Jerry A. Lineback



ISGS 1981



## DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

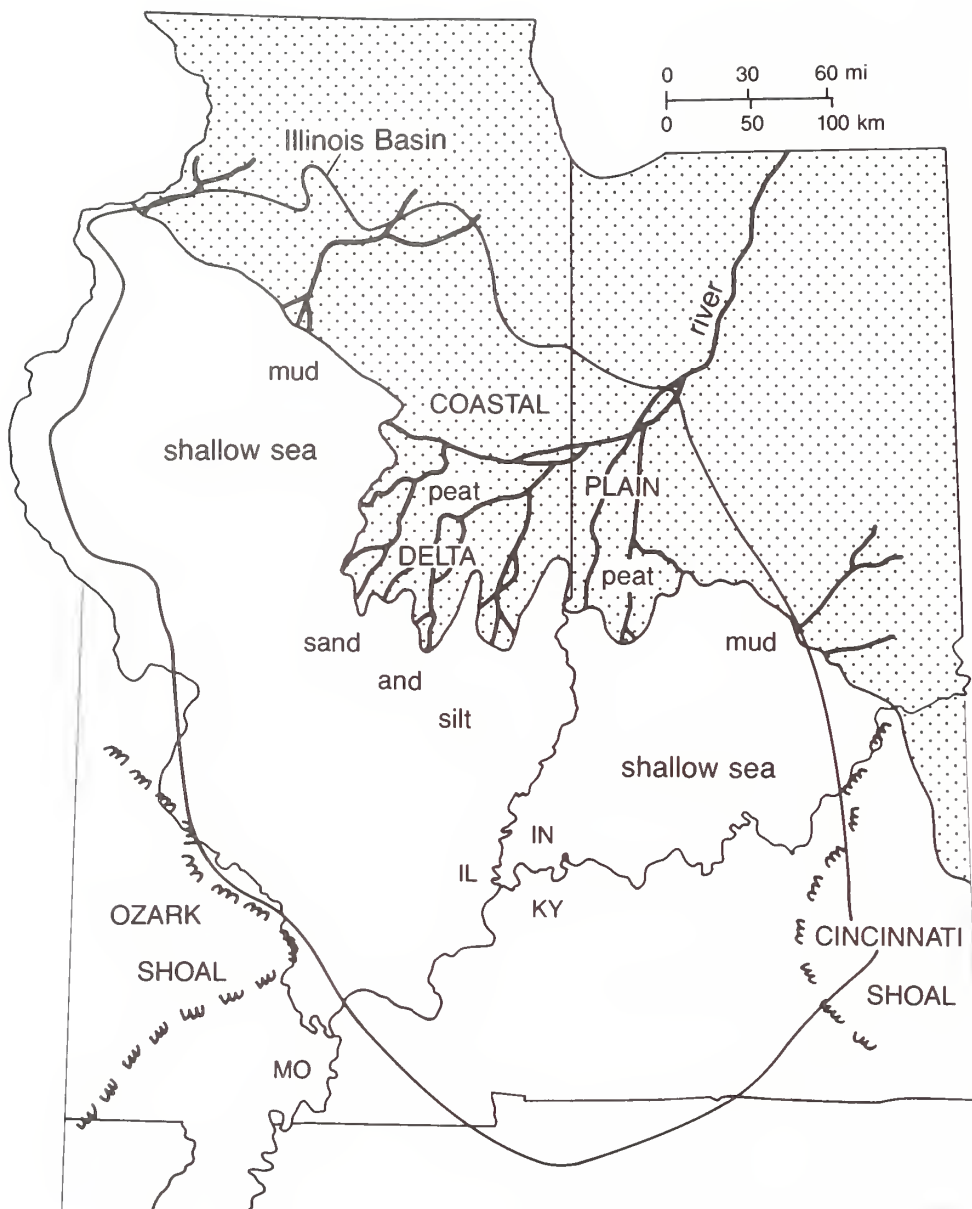
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



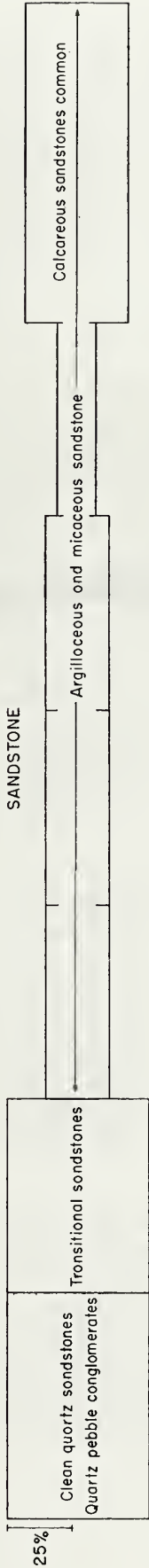
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

### Pennsylvanian Cyclothem

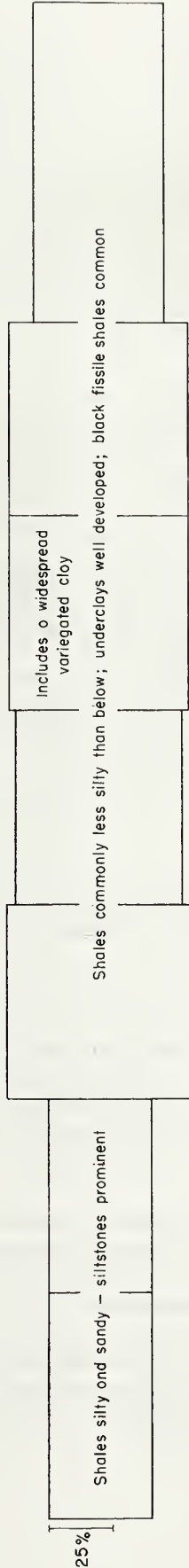
The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



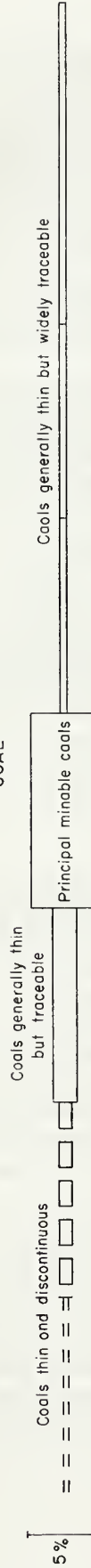
McCORMICK GROUP		KEWANEE GROUP		MCLEANSBORO GROUP		
Caseyville Fm.	Abbott Fm.	Spoon Fm.	Carbondale Fm.	Modesto Fm.	Bond Fm.	Mattoon Fm.



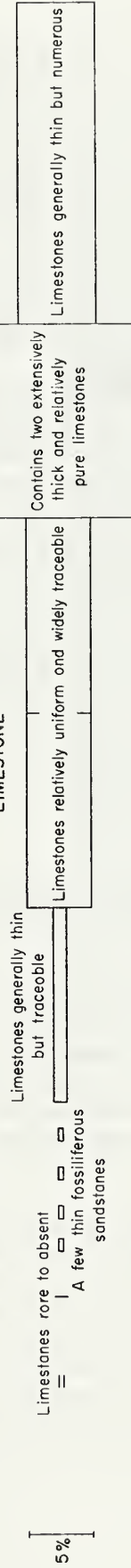
#### SHALE



#### COAL

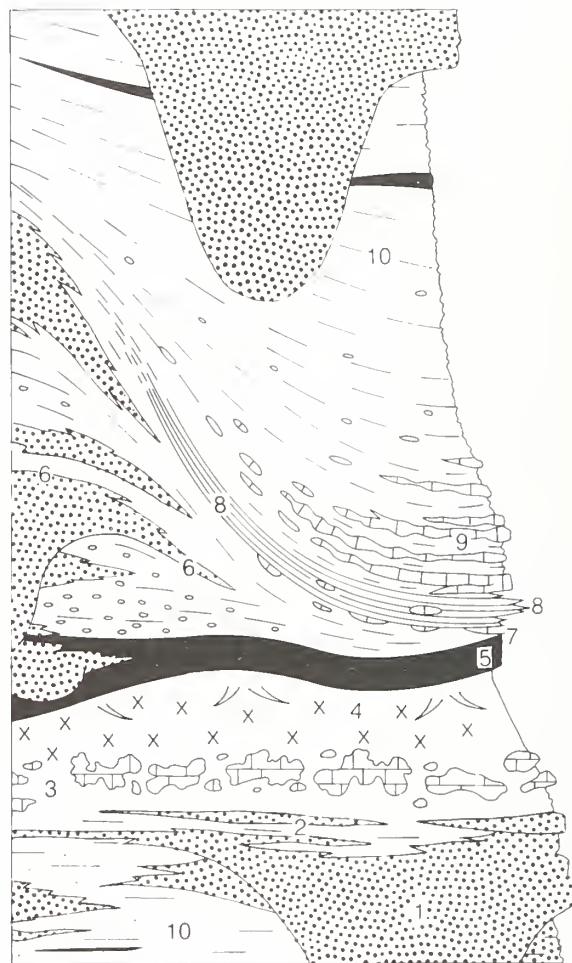
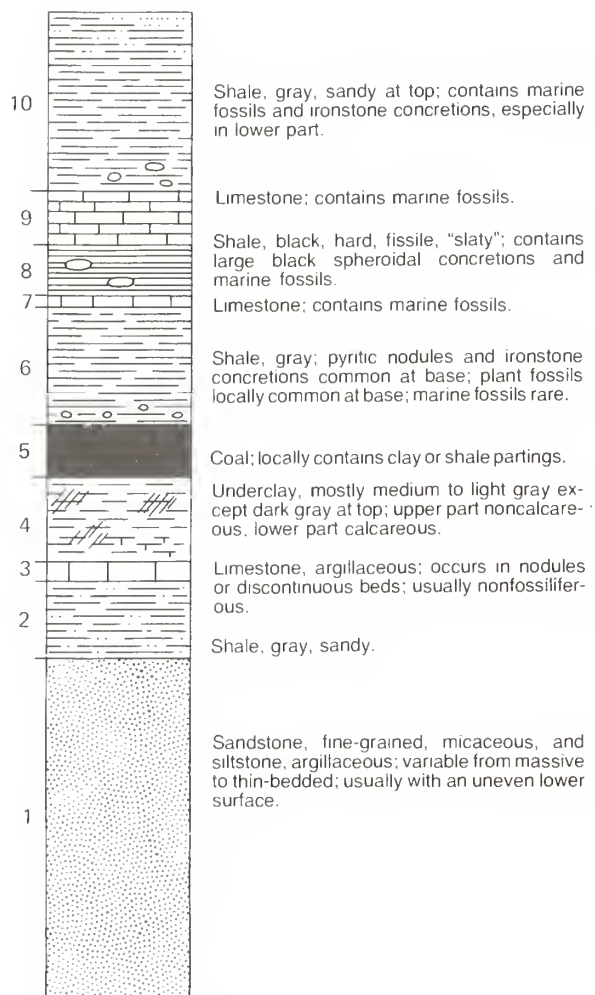


#### LIMESTONE



— AVERAGE THICKNESS —  
Scale 100 ft.

General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothem have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheeted shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.

## Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothem. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its course. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich





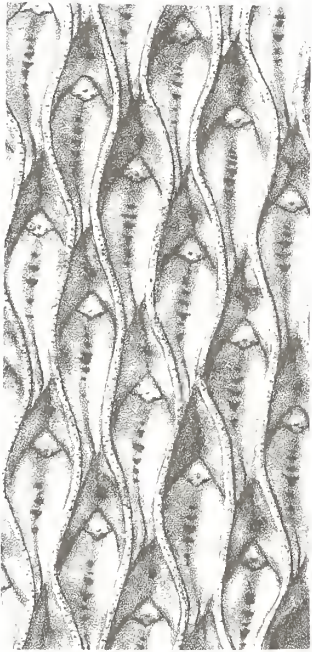
mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the “depauperate” fauna consists mostly of normal-size individuals of species that never grew any larger.

### References

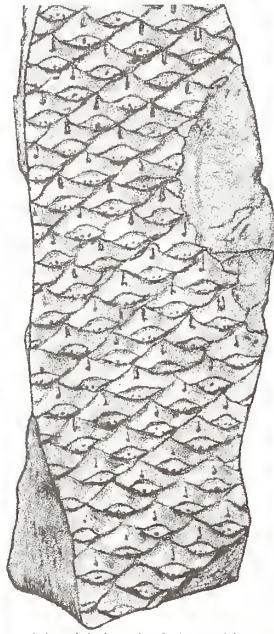
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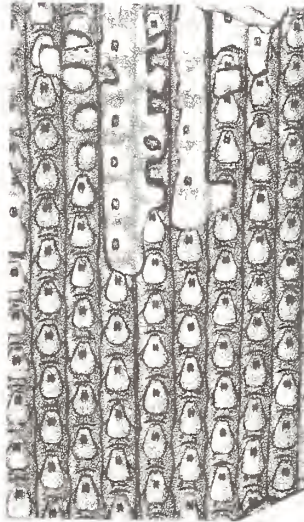
# Common Pennsylvanian plants: lycopods, sphenophytes, and ferns



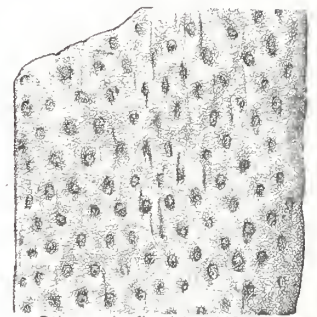
*Lepidodendron aculeatum* X0.8



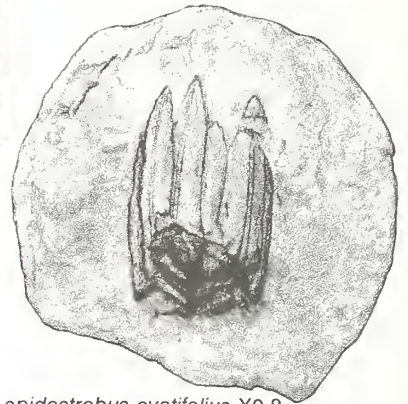
*Lepidophloios laricinus* X0.63



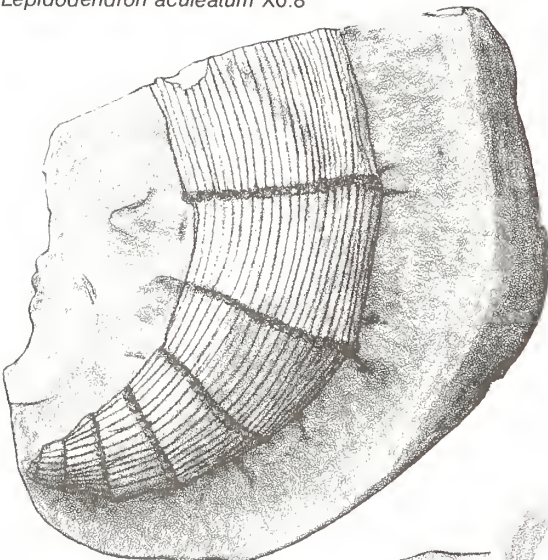
*Sigillaria mammilaris* X0.5



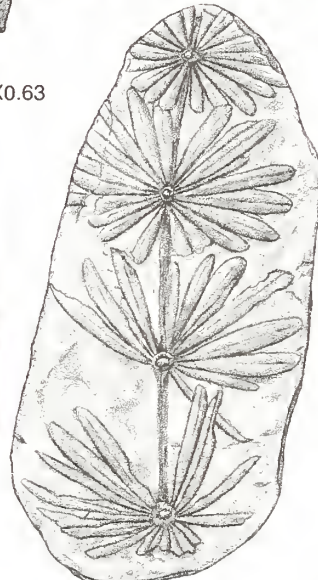
*Stigmaria ficoides* X0.32



*Lepidostrobus ovatifolius* X0.8



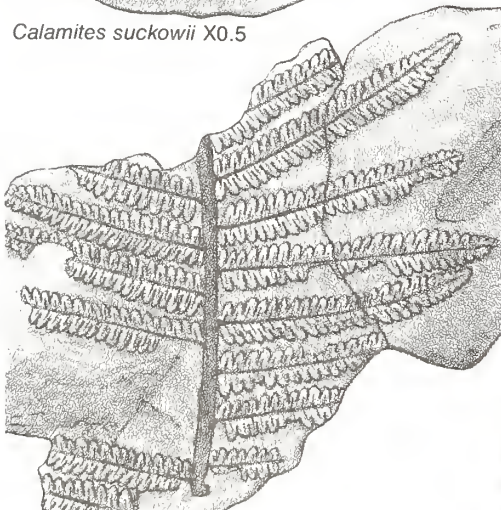
*Calamites suckowii* X0.5



*Annularia stellata* X0.63



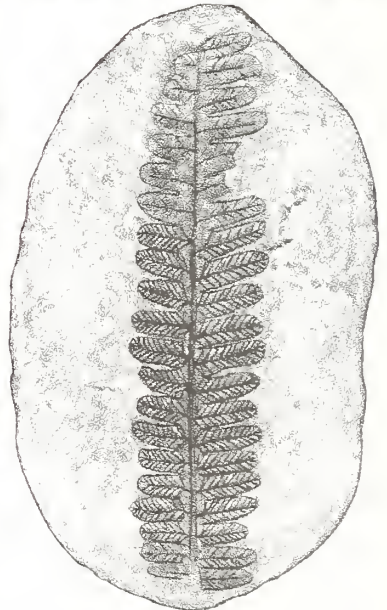
*Sphenophyllum cuneifolium* X0.4



*Pecopteris* sp. X0.32



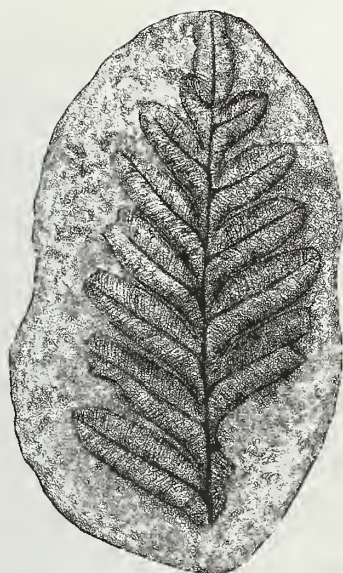
*Pecopteris miltonii* X2.0



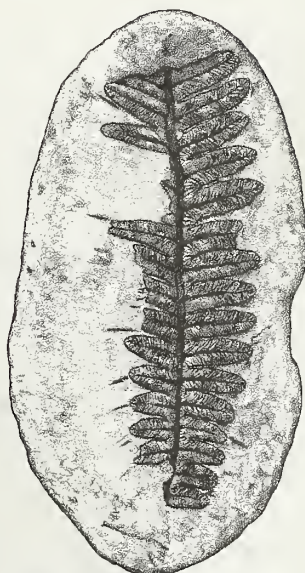
*Pecopteris hemitelioides* X1.0



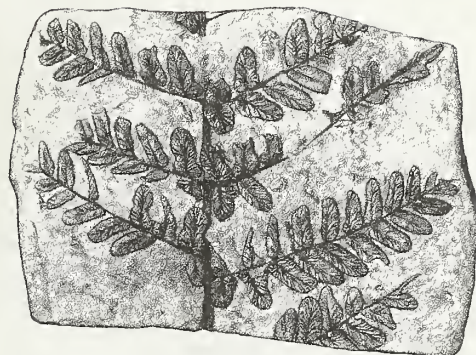
# Common Pennsylvanian plants: seed ferns and cordaites



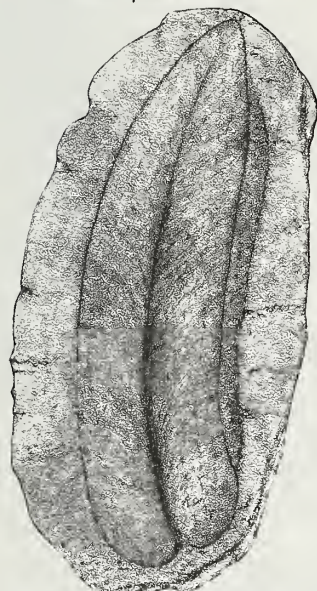
*Alethopteris serlii* X0.63



*Alethopteris ambigua* X0.63



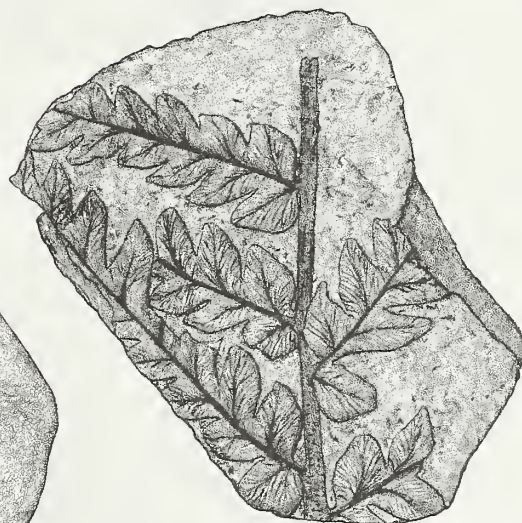
*Neuropteris rarinervis* X0.5



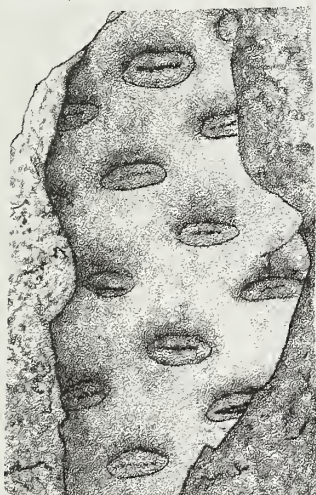
*Neuropteris scheuchzeri* X0.63



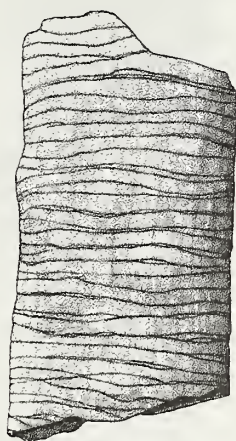
*Sphenopteris rotundiloba* X0.8



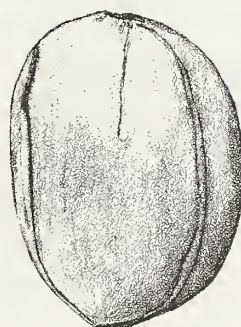
*Mariopteris nervosa* X0.8



*Cordaiacladus* sp. X1.0



*Artisia transversa* X0.63



*Trigonocarpus parkinsonii* X1.25



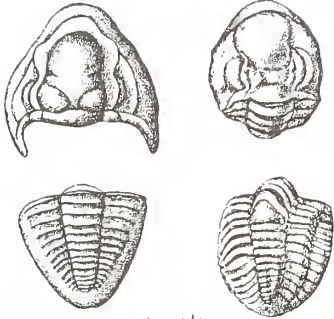
*Cordaicarpon major* X2.0



*Cordaites principalis* X0.63



### TRILOBITES



*Ameura sangamonensis*  $1\frac{1}{3}x$

*Ditomopyge parvulus*  $1\frac{1}{2}x$

### CORALS



*Lophophlidium proliferum*  $1x$

### FUSULINIDS



*Fusulina ocme*  $5x$



*Fusulina girtyi*  $5x$

### CEPHALOPODS



*Pseudarthoceros knoxense*  $1x$



*Glophrites welleri*  $2\frac{2}{3}x$



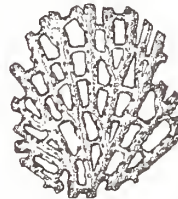
### BRYOZOANS



*Fenestrellino mimica*  $9x$

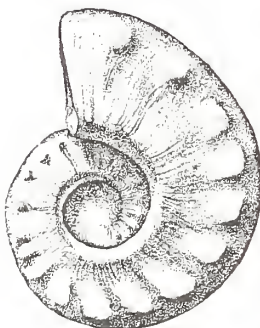


*Rhombopora lepidodendroides*

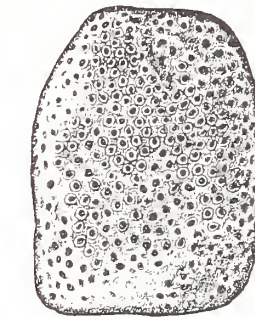
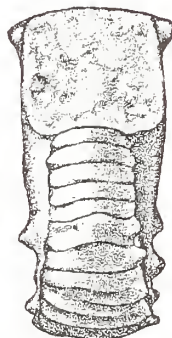


*Fenestrellina modesta*  $10x$

$6x$



*Metacoceros cornutum*  $1\frac{1}{2}x$



*Fistulipora carbonaria*  $3\frac{1}{3}x$



*Prismapora triangulata*  $12x$

## PELECYPODS



*Nuculo (Nuculopsis) girtyi* 1x



*Edmonia avata* 2x



*Astartella concentrica* 1x



*Dunbarella knighti* 1 1/2 x



*Cardiamarpha missouriensis*  
"Type A" 1x



*Cardiamarpha missouriensis*  
"Type B" 1 1/2 x

## GASTROPODS



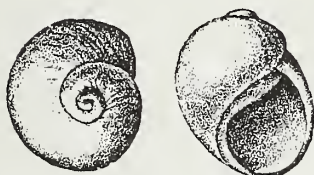
*Euphemites carbanarius* 1 1/2 x



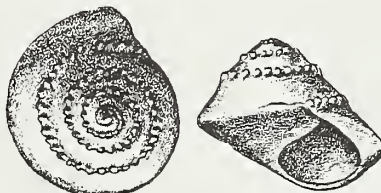
*Trepaspira illinoisensis* 1 1/2 x



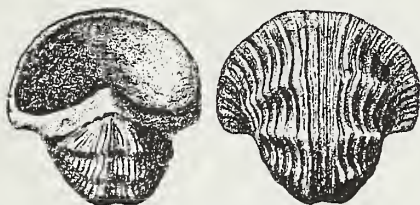
*Danaldina robusta* 8x



*Naticopsis (Jedria) ventricosa* 1 1/2 x



*Trepaspira sphaerulata* 1x



*Knightites mantfortianus* 2x



*Glabracingulum (Glabracingulum) grayvillense* 3x



# BRACHIOPODS



*Juresania nebrascensis* 2/3 x



*Derbya crassa* 1x



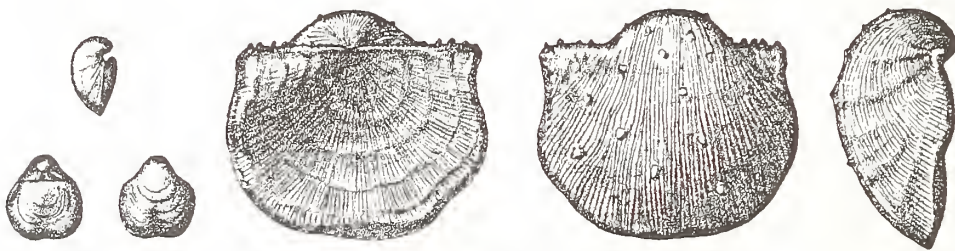
*Campasito argentia* 1x



*Neospirifer comerotus* 1x



*Chonetes granulifer* 1 1/2 x *Mesolobus mesolobus* var. *evampygus* 2x *Marginifera splendens* 1x



*Grurithyris planoconvexa* 2x

*Linopraductus "cora"* 1x



